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THE CORAL COASTS OF INDIA: *A paper read at the Evening Meeting of the Society on 21 March 1932, by*

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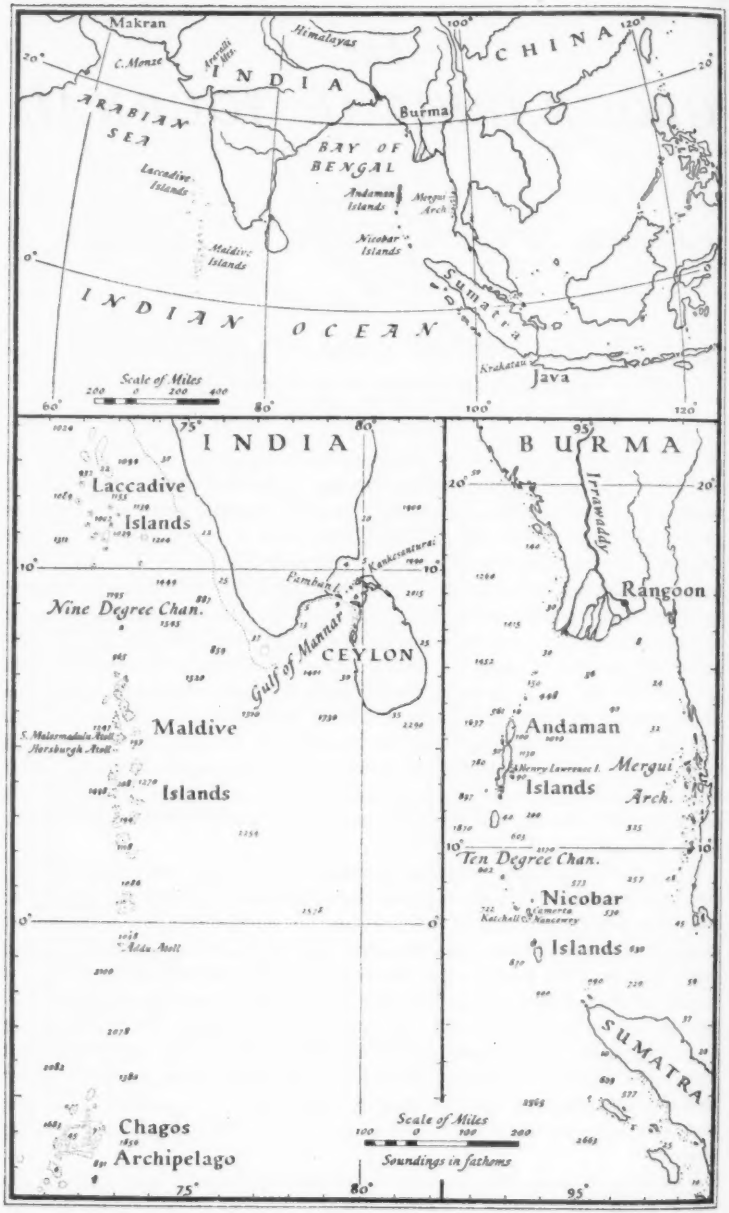
ONE hundred years ago on December 27 last H.M.S. *Beagle* sailed from Devonport and commenced her voyage round the world: a voyage that occupied nearly five years, for she only reached England again on 2 October 1836, and I need hardly remind this Society that it was on this voyage that Charles Darwin, then a young man of twenty-two years of age, had the opportunity of studying nature in many different parts of the globe and thus laid the foundation of his life's work. During this voyage Darwin was able to make observations on some of the coral islands of the Pacific Ocean and a comparatively detailed study of the Cocos-Keeling Atoll in the Indian Ocean, an account of which he gives in his *Journal*, that was first published in 1839, and again and rather more fully in his work on Coral Reefs, published in 1842. During a part of the time when the *Beagle* was making her voyage, from 1834–36, Captain R. Moresby and Lieut. Powell were conducting a survey of the Maldive and Laccadive Archipelagoes, that lie to the west and south-west of India, and Moresby published his account of the Maldive atolls in vol. v of the *Journal*, R.G.S., in 1835.

Coral reefs are usually classified into three main groups: (*a*) Fringing reefs, that lie close to land and run out into the sea for varying distances; (*b*) barrier reefs, that usually run parallel to some coast but separated from it by a channel of deep water; such reefs may be either linear or circular, depending on the configuration of the land, the best-known example of the type being the Great Barrier Reef of Australia; and (*c*) atolls, in which the coral formation usually has the form of a circle or oval enclosing a central lagoon. No hard-and-fast line of distinction can be drawn between these three groups, and Darwin put forward the theory that they all three represent stages in one process brought about by subsidence of the foundation on which the coral is growing, a fringing reef becoming a barrier reef, and this in turn with further subsidence becoming an atoll.

There can, I think, be little doubt that in arriving at this conclusion Darwin was to some, and possibly to a great, extent influenced by Moresby's work on the Maldives. Section 3 of his first chapter in 'Coral Reefs' deals solely with



Coral Reefs of India

the Maldive atolls, and in his opening paragraph Darwin remarks: "My description is derived from an examination of the admirable charts lately published from the survey of Captain Moresby and Lieut. Powell, and more especially from information which Captain Moresby has communicated to me in the kindest manner." Since Darwin's day other theories have been put forward to account for the origin and evolution of these various types of coral formations, but I do not propose to consider these in any detail; suffice it to say that it is now universally accepted that these reefs must have been built up on a foundation that lay not more than 50 fathoms (or 300 feet) below the surface, and that coral-growth cannot have extended upwards above the level of low-water neap tides. Below this depth reef-forming corals cannot thrive, and above this height exposure to the air kills them off.

Throughout the tropical region coral growth is abundant, and in Indian waters we have numerous examples of reefs of all kinds, though round peninsular India itself there is, except for a small length of coast at the extreme south end, an absence of such reefs owing to the effects of fresh water and mud brought down by the great rivers. I propose to attempt to trace the changes that are taking place in some of these reefs at the present day, and the information contained in this paper has been gathered from a study of these reefs in the Mergui Archipelago off the coast of southern Burma, in the Andaman and Nicobar Islands on the east side of the Bay of Bengal and in the Maldive Islands on the south-west of India. In studies such as this one has, perforce, to be not only a zoologist, but also something of a chemist, a physicist, a geologist, and even a meteorologist; in order to understand the conditions that have led to the existence of the reefs as we find them and to the changes that are now taking place, it is necessary to study India's

> "Silver heights,
> Unvisited with dew of vagrant cloud,
> And the unsounded, undescended depths
> Of her black hollows",

as well as the varying changes of the seasons, for these have a very pronounced influence on the conditions that exist in the waters themselves.

Throughout the ages the great mass of the Indian Peninsula has stood firm, but at the beginning of the Tertiary epoch a series of great earth-movements began to make themselves felt all around it and finally resulted in producing the picture that we see to-day. Right across the belt that lay to the northern side of peninsular India began the great upheaval of the Himalayas, the central portion of the great chain of mountains that begins in the west in the Alps of Europe and is continued on past India to the mountain chains of China in the east. Simultaneously other subsidiary ranges arose on the east side of India and now form the backbone of the Malay Archipelago, and one of these latter ranges formed the arc that extends down the west side of Burma and is continued on through Sumatra and Java. At some later period, probably in the Pliocene epoch, the central portion of this latter range underwent subsidence and a tract of land gradually sank and almost completely disappeared beneath the sea, leaving only the topmost peaks standing above the surface, where to-day they form the chain of the Andaman and Nicobar Islands. Most geologists are

also agreed that in Eocene or Miocene times the coast of India lay much farther to the westward than it does at the present day. In the latter part of the Tertiary epoch there seems to have been a very extensive subsidence of a tract of land, accompanied by extensive "faulting" along what is now India's west coast. One such fault appears to exist along the Makran coast from a little west of Cape Monze towards the entrance of the Persian Gulf, and a second and even more extensive fault runs down the west coast of India. A study of the submarine contours of the region to the west of India shows that we can trace a continuation of the Hala mountains as a submarine ridge running to the west, while in a north-and-south line we get a great mountain chain, which I believe to be the continuation of the Aravalli Mountains, the oldest mountain chain in India. To what extent the total submergence of this great range is to be attributed to actual subsidence or to the fall of sea-level that occurred during the last Glacial period, combined with sub-aërial and marine, or possibly even sub-marine, erosion, I am not prepared to say. At the present time all trace of actual land has completely disappeared beneath the sea, and the tops of the mountain peaks are covered by one of the finest series of atolls in the world, that stretches for some 1500 miles along the 72nd and 73rd meridians east of Greenwich. As one would expect in a mountain range of this magnitude, the continuity is broken by gaps or deep channels, that correspond to the passes that one finds in mountain ranges on land; and as a result of these gaps the various atolls can be grouped geographically into the Laccadives at the north; the Maldives, separated from the Laccadives by Nine Degree channel, in the middle; and at the extreme south, separated from the Maldives by a wide interval, the Chagos Archipelago.

In recent years it has been recognized that the sea-level is by no means such a fixed and constant thing as was previously thought. Indeed, Darwin himself called attention to the fact that in a number of coral reefs there seemed to be evidence in favour of a recent change in level, and he remarks* that if this should be confirmed, "the question will arise, seeing how immense an area has thus been affected, whether these geologists are not right who believe that the level of the ocean is subject to secular changes from astronomical causes." Throughout the tropical regions of all the great oceans there has accumulated in recent years a mass of evidence, in the shape of raised coral reefs, wave-worn "benches" or ledges cut in rock cliffs and raised sea-beaches, that inevitably points to the conclusion that within quite recent times, stated by competent observers, such as Daly† and Edgeworth David,‡ to have been only about 3500 or 4000 years ago, there occurred a fall of sea-level of about 20 feet throughout the whole tropical and sub-tropical region of the globe. Stanley Gardiner§ has pointed out that the degree of apparent elevation of the land that can be detected varies in different regions with latitude and the neighbouring topography, and he suggests that the fall of sea-level may be due to the commencement of a new Antarctic Glacial Period. Be this as it may, there can

*'Coral Reefs,' p. 173 (Third Edition).

†*Geological Magazine*, vol. lvii, 1920; and 'Our Mobile Earth,' New York, 1926.

‡Lecture to the Geological Society, London, April 1926.

§"Studies in Coral Reefs," *Bull. Mus. Comp. Zool. Harvard*, vol. lxxi, no. 1, p. 13, footnote 2.

Outer zone of raised reef, Pamban Island

Sandstone formation behind the raised reef, Pamban Island

Growing edge of fringing reef off Reed Point, Nancowry Harbour, Nicobar Islands

Growing edge of fringing reef off Reed Point, Nancowry Harbour, Nicobar Islands

be no doubt of the actuality of the change of sea-level in the Indian region, and it is extremely interesting to try and see the extent to which this change has influenced and affected the coral reefs in various areas.

In order to get a true picture of the effect that such a change may have produced, it is essential that we should clearly picture what the condition of a reef would be in a region where there had been no such change. Since this fall of sea-level has been universal and is of quite recent occurrence, it is extremely difficult, if not, indeed, impossible, to find such a reef; but there is one situated off Reed Point, at the north-east corner of Nancowry Island, at the eastern entrance to the harbour of that name in the central group of the Nicobars, that seems to conform very nearly to our requirements. At its widest part the reef has a width of nearly one-quarter of a mile and, except at extreme low-water spring tides, is entirely covered. The margin of the reef consists of a prolific growth of coral (? *Porites*) that at the top possesses a branching facies, the branches in many places being set parallel to the edge of the reef and at right angles to the to-and-fro wash of the waves. On the outer face, which, so far as I could see, is composed of masses of solid coral, the reef drops steeply into 10 fathoms of water. Between the outer margin of the reef and the shore the reef-surface is covered by about 1 foot of water even at the lowest states of the tide, and is composed of a mass of solid coral rock, with occasional holes and crevices, growing on which are numerous colonies of *Heliopora coerulea*, the importance of which in reef formation was pointed out by Sollas in his account of the Atoll of Funafuti.* The character of a reef may vary enormously in accordance with the conditions that prevail in the area in which it is growing; where the reef is exposed to heavy wave action the predominant character of the margin will be one of solidarity, the reef being formed of massive corals largely bound together by the calcareous alga *Lithothamnion*, whereas in sheltered spots the main type of growth will be more delicate and we may get large areas of branching stag-horn forms, such as *Acropora*, or flattened plate-like forms of Madrepore, and in another reef in Nancowry Harbour, on the opposite side to the one we have just considered, the reef surface is covered on its outer zone with a profuse leathery growth of *Sarcophytum*, while in the inner zone the coral consists almost entirely of Madrepore of a branching type.

In every coral area two diametrically opposed processes are continually going on, the one constructive and the other destructive. The constructive processes include the continual growth of the coral itself and, proceeding simultaneously with this, the gradual accumulation of dead fragments. All along the seaward edge of the reef coral flourishes, but the impact of the waves is continually breaking off fragments, the size of which will depend on the character of the coral and the force of the waves; boring organisms, such as worms, molluscs, and even sponges, cause the separation and death of larger and smaller fragments, and these in turn are attacked by Holothurians and allied forms, that feed on them and finally reduce them to a fine sand or mud that is swept inwards across the reef and is either deposited on the surface or swept farther on to be deposited in the case of a fringing reef on the shore behind it or in the case of an atoll or barrier reef swept over the inner margin

*'The Atoll of Funafuti,' Report of Coral Reef Committee, Royal Society, London, 1904, p. 20.

into the lagoon or boat channel. The distance to which these fragments are swept will depend on their size and the strength of the currents of water that sweep over the reef. Saville Kent* put forward the view that the formation of a coral reef is due primarily to the formation of coral conglomerate and limestone by the binding together of such fragments, and is not *per se* due primarily to the growth of the coral itself; and this has, I think, been generally accepted. Darwin† himself had recognized that such a process must have been going on in the lagoon reefs of the atolls, for he remarks, "the corals, which lived in the lagoon reefs at each successive level, would be preserved upright and they would consist of many kinds, generally much branched. In this part however a very large proportion of the rock, and in some cases nearly all of it, would be formed of sedimentary matter, being in an excessively fine or moderately coarse state, with the particles almost blended together."

In the case of such fringing reefs as one sees along the Andaman and Nicobar coasts the detritus from the reef becomes piled up in banks in sheltered areas and along the shore and gradually becomes overgrown with vegetation, so that the land, on the whole, tends to increase, but in such a reef as that on Kurisadi Island at the head of the Gulf of Mannar, where the force of the waves during the south-west monsoon is in all probability considerable, there may be formed a quite distinct boulder zone, that is comparable to the boulder zone that is found on the outer reefs of the atolls in the Maldives, situated in mid-ocean.

The next point that we have to consider is the character of the change that will take place in a sandy beach such as may be formed behind a reef by the accumulation of sand and small coral fragments. The principle change will be one of consolidation and the formation of a conglomerate or sandstone, the character of the rock depending on the size of the particles of which the raised beach is composed. Here again we find that Darwin (*loc. cit.*) clearly recognizes that "the conglomerate that was formed of rounded pieces of the branched corals on the shores of the lagoon would differ from that formed on the islets (of an atoll) and derived from the outer coast; although both might have been accumulated very near to each other. The stratification, taken as a whole, would be horizontal; but the conglomerate beds resting on the exterior reef and the beds of sandstone on the shores of the lagoon and on the external flanks of the reef would probably be divided by numerous layers dipping at considerable angles in different directions." Wherever one gets a deposit of sand or other fragments composed, for the most part or entirely, of calcareous material, one finds that as a result of the percolation downwards from the surface of water either from rain or spray from the sea, a layer of sandstone is formed at a depth that is in the main fairly constant, namely at 3 to 6 feet. The formation of this band of rock is due to the solution of calcium carbonate by the water in the upper layer and its deposition at the deeper level. Examples of this formation are too numerous to mention, and I will content myself here with quoting from a recent paper by Stanley Gardiner:‡ "At the bases of dunes a sandstone with certain resemblances and dipping more or less as does the

*"The Great Barrier Reef of Australia," London, 1893.
†'Coral Reefs,' p. 156 (Third Edition).
‡"Studies in Coral Reefs," *Bull. Mus. Comp. Zool. Harvard*, vol. lxxi, p. 15.

sand of the dune was found near Kankasanturai, north Ceylon, in Farquhar and Coetivy. . . . This dune sandstone was all covered with loose sand, of which a thickness of at least four to six feet seemed usual. . . . Clearly this sandstone can only be formed by evaporation of fresh-water saturated with carbonate of calcium." Wherever I have dug down in one of these sandy beaches or flats I have always found the same structure, and I have little doubt that it is of universal occurrence, provided that the sand formation has been in existence sufficiently long to allow of its consolidation. Beneath the sand of beaches that are composed of calcareous material we get the formation between tide-marks of the so-called "beach sand-stone," usually considerably harder, so far as the outermost layers are concerned, than the sandstone that is formed under the surface of the sandy island or flat, but in my opinion the two formations grade one into the other, such differences as are found being only of degree and due to the different conditions under which they are formed. Wherever this sandstone is found exposed, if my conclusion is right, we not only have evidence of erosion, as was pointed out many years ago by Stanley Gardiner,* but we also have evidence of the character of the sand formation in which this stone was deposited; thus, if the slope is seaward, the sandstone was formed on the seaward side of the sand ridge, whereas if it be in the opposite direction, *i.e.* away from the sea, its formation must have taken place under the reverse slope.

We are fortunate in having in India a very good example of a raised reef, a study of which enables us to test the validity of this view. Foote† called attention to the existence of this reef on the south extremity of the Indian Peninsula, and in 1926 I spent some weeks in that vicinity examining the reef and the surrounding coast. At the present time there is very little of the actual coral of the reef margin still to be seen, but some remains at the extreme north-east of Pamban (Rameswaram) Island, that lies between India and Ceylon, close to where the railway bridge now carries the line from Mandapam across the Pamban Strait. As one walks northward along the seashore one comes first on an exposure of a bed of conglomerate, composed of sand and shells mixed with a certain amount of broken coral-fragments, and lying horizontally; these sub-fossil shells are all species that are common at the present day along the edge of the beach. The upper level of the deposit now lies at a height of some 6 feet above the present high-water mark, though it is clear that the original deposit was laid down in shallow water. About 100 yards to the north of this is an exposure of a pure sandstone that exhibits a well-marked stratification and a dip towards the west or south-west at an angle of about 1 in 2. A little farther on one finds a second formation of sandstone, but now the dip of the stratification is towards the north-east, while the extreme upper stratum is horizontal. Beyond this second sandstone formation on the sea-face there is a small spit, consisting of several masses of dead coral that are clearly still *in situ*, while others of smaller size are embedded in the sandstone along the exposed face. The majority of these corals belong to species of a massive character, and from

*'Fauna and Geography of the Maldive and Laccadive Archipelagoes,' 1903, p. 341 *et seq.*

†"The Coral Reefs of Rameswaram Island," *Madras Christian Coll. Mag.*, May 1889 (Abstract in *Scott. Geogr. Mag.*, vol. vi, 1890).

the general appearance of the whole structure one can only conclude that we have here the remains of the old fringing reef, behind which sand and coral-fragments were piled up by wind and wave action into a ridge, and that within this ridge there was formed by percolation, in the manner that I have indicated, a secondary sandstone, the dip of the stratification of which still reveals the slope of the ridge on its two sides, while behind it again was a shallow water area in which numerous molluscs flourished. My view, then, regarding the importance of a study of the slope of this sandstone would appear to be sound. At the same time this reef provides clear evidence of the relative alteration of sea- and land-level in comparatively recent times. Beyond this old raised reef a new fringing reef has been formed at the new level.

One is at first inclined to regard the presence of a coral-reef along a coast as a protection against erosion, inasmuch as the force of the waves and their consequent erosive action must to a large extent be expended on the reef margin; but such protection is only comparative and is not absolute. Across the reef flat, with every rise and fall of the tide, strong currents are set up, and these are heavily charged with sand that scours away the surface of any obstacle. Baker* has called attention to the erosion that is going on at the present day behind a coral reef in the New Hebrides, and Crossland† has also described the quite marked erosion that can be seen in some of the reefs of certain other atolls in the Pacific. Similar examples are to be seen in various parts of the coast in the Andaman and Nicobar Islands. In the Andaman Islands, at the south end of Henry Lawrence Island, is a small bay the floor of which is completely composed of coral that originally formed part of a flourishing reef, but which, owing to a change in the relative levels of sea and land, has now been killed off; outside this a new reef has been formed. Around this bay are fine cliffs composed of a stratified clay, and these show clear signs of erosion, the extreme end of the cliff being under-cut and at one place a tunnel having been driven through, while in other parts fallen masses of the cliff can be seen at the top of the beach. In a clay formation such as this, erosion would be comparatively easy; but in the Nicobar Islands there is another bay that shows the same feature; this is situated on Katchall Island, which is composed of a hard limestone. Here again the beach is composed of masses of dead coral that once formed part of a reef but have been killed by a change of level, and at the top of the beach are several isolated masses of limestone that show clear evidence of erosion, in spite of the fact that outside the old and dead reef a new flourishing coral-reef has sprung up and that the situation is an extremely sheltered one in the channel that runs between Katchall Island on the west and Camorta and Nancowry Islands on the east.

The recognition of the fact that erosion can and does go on behind the shelter of a coral-reef, even in a sheltered area, is of vital importance when we try to trace the changes that are going on in the islands of the Maldive atolls. It is also very necessary that we should be able to recognize the various types of rock that are exposed by this erosion and thus be able to form an opinion as

*"A Coral Reef in the New Hebrides," *Proc. Zool. Soc.*, London, part ii, 1925.

†"Coral Reefs of Tahiti, Moorea, and Rarotonga," *Journ. Linn. Soc. London, Zool.*, vol. xxxvi, 1928.

to the locality in which the rock was originally formed. These four types of rock to which I shall hereafter refer are:

(1) The hard Breccia, that is formed partly by coral-growth and partly, and possibly to a large extent, by *Lithothamnion*. This formation at one time constituted the outer margin of the reef and the outer part of the reef-flat.

(2) Conglomerate, consisting for the most part of small broken masses of coral, mixed with shells and Foraminifera, that was originally part of the reef flat and especially of the area towards the lagoon.

(3) Beach sandstone, that is a more recent formation and is deposited between tide-marks along the present shores of the islands by the consolidation of sand and other calcareous fragments that are washed up and then become cemented together by the deposition of calcium carbonate; and

(4) The sandstone that is formed beneath the calcareous sand of the raised beaches and that exhibits a slope in conformity with that of the surface beneath which it has been deposited.

As I have already mentioned, these two last types appear in places to grade into each other.

Edgeworth David and Sweet, in their account of Funafuti, stated that in their opinion the fall of sea-level had given rise to long stretches of land that subsequently became cut through by erosion and so gave rise to the separate islands that are present on the atoll to-day; Stanley Gardiner has also emphasized that it is to this relative elevation of the old reef that we must attribute the formation of the islands, the fall of sea-level having originally caused the emergence of a complete rim of dry land, only interrupted by the gaps where the deep entrance channels to the lagoon were situated. This rim will have consisted of a hard coral breccia, formed by the original growing coral and *Lithothamnion* of the reef margin, but with the change of level these would have been killed off and the rock would have at once been exposed to the erosive action of the waves. Here again Darwin* clearly foresaw what the result of such a contingency would be, for he remarks, "should the outer and living margin perish, of any one of the many low coral-islands, round which a line of great breakers is incessantly foaming, the whole, it is scarcely possible to doubt, would be washed away and destroyed"; Darwin however considerably underestimated the length of time that would be necessary to accomplish this action, for he put it at "less than half a century." The effect of this death of the reef-margin and the raising of the level of the dead reef would be twofold; first, the destruction of the old raised reef edge and the gradual wearing down of the level of the reef flat, and, secondly, the piling up of the broken-off masses of coral and rock to form a raised boulder or "hurricane" beach. As a result of the further erosion coral masses would be gradually ground to smaller fragments, and these in turn to a fine sand, this latter process being expedited by the action of numerous sand-triturating organisms. The sand would be thrown up by wind- and wave-action on to the beach and thus help to consolidate it; similar, though less powerful, action would also be going on on the lagoon side, owing to the action of the waves in the lagoon.

A typical island, then, should consist of a raised platform of the old coral

*'Coral Reefs,' p. 86 (Third Edition).

breccia on which has been thrown up an outer rampart of coral fragments, the "hurricane" beach; behind this there should be a larger or smaller area, depending on the degree to which sand has been drifted against the reverse slope of the hurricane beach and has subsequently been protected against erosion and solution by the growth of vegetation on it. Along the inner or lagoon side a smaller raised rim, sometimes called the lagoon mound, composed of sand with small fragments of coral, mollusc shells, foraminifera, etc., will be raised by the effect of the lagoon waves. Such an island should be situated close to what was at the time of its formation the ocean rim of the atoll, but at the present day very few islands are found in this situation or show all the above characters. In almost every case a careful study will reveal unmistakable evidence of erosion, and hand in hand with this erosion there goes on a steady alteration in the position of the island on the reef flat; as the outer margin is washed away, sand drifts round between the islands and is deposited on the inner lagoon shore, and there is thus a steady migration of the island across the reef-flat towards the lagoon. There are however certain exceptions to this almost universal rule, and these are to be found in small islands that seem to have been thrown up in certain special localities, where there is a cross-set of the waves. The existence of such islets was known to Darwin,* who remarks, "the occurrence of islets, as if placed for beacons, on the points where there is a gateway or breach through the reef, has been noticed by several authors," but Darwin failed to distinguish between these and the primary islands that have been formed in the manner that I have already indicated. Such islets as these will not, of course, show any traces of erosion.

The degree to which the primary islands have undergone erosion should be correlated with the degree to which the islands are exposed to heavy seas, and this again will depend on the geographical situation of the atoll and the position of the island on the atoll itself. In the Laccadive-Maldive group the strongest wind comes from the south-west, with occasional violent storms from the north-west to north-east during the occurrence of cyclones in the Laccadive Sea. The strength of the south-west wind however is not uniform throughout the whole belt but appears to be strongest in the Laccadive region; in the Maldive area, as Agassiz† has pointed out, the strength of the south-west monsoon diminishes as we proceed from north to south, and the most southerly atoll, Addu, lies in the region of variable winds beyond the influence of the monsoons. So far as my experience goes, at the southern end of the Maldives, in the region of the Equator, the strongest wind appears to come from the north-west and only secondarily from the south-west, while the effect of the north-east monsoon is comparatively small and the south-east side of an atoll is but little affected.

The least amount of erosion should then be found in this latter situation. On the east side of the south-east entrance to Addu atoll lies the island Mulikadu; here, as we pass inwards from the reef margin, we find a sloping rocky platform, composed of numerous fragments of coral, that to me appear to be the cemented fragments of the old boulder zone, and immediately above this

*'Coral Reefs,' p. 29 (Third Edition).

†"The Coral Reefs of the Maldives," *Mem. Mus. Comp. Zool. Harvard*, vol. xxix, p. 8, 1903.

lies the hurricane beach, composed of small fragments of coral thrown up by the waves. Immediately inside this ridge there is a shallow pool, the bed of which is composed of the same hard rock as the reef face, while forming the inner margin of the pool is a series of raised ridges of coral shingle that have been thrown up by the lagoon waves during storms from the north-west. It is interesting to note that this and a small sandy island in the middle of the lagoon were the only islands in the atoll on which the black-naped Tern (*Sterna melanauchen*) was breeding.

On the east side of the same atoll, a little farther north, is the island Heratera (or Putali); here erosion has begun, and the breccia of the old reef-flat is exposed and eroded; it was through this beach, but a little farther to the south, that the sea during the time of my visit burst its way through during a storm and so began the process of separating the island into two.

Continuing farther to the north we come to that part of the atoll in which we may expect to get the full result of such force as the north-east monsoon can exert in this latitude, and at the south-east corner of the island of Midu we get clear traces of erosion. The rocky breccia, that forms the basis of all these islands, is here well exposed and in places is eroded into low cliffs. The mass in the foreground clearly shows the dip of the stratification downwards towards the reef-margin, which is a characteristic feature of this outer reef-breccia.

On the south-west face of the same atoll we have the area in which we should expect to get the still stronger effect of the south-west monsoon and, in consequence, still further erosion. In this situation there is a well-formed boulder zone, composed of masses of dead coral, that have been thrown up in all directions, some of them large enough to warrant the use of the term "negro-head," which is applied to the large masses of coral that are found in the atolls of the Pacific. Isolated coral fragments can be seen scattered in all positions, and running inwards, away from the reef margin, are lines and spits of coral boulders. Inside this boulder zone is a belt of shallow water, in which is standing a line of isolated rocks or so-called "sea-horses," that once were part of the breccia foundation of an island that has now been driven inwards towards the lagoon. Here again we can see the dip of the stratum towards the reef margin and the manner in which erosion is still going on, so that ultimately even these masses of rock will disappear. On this aspect of the atoll some of the islands have been driven so far inwards towards the lagoon that in places the conglomerate of the old lagoon-reef has been exposed on their seaward face, and this also is undergoing erosion.

As erosion on the seaward portion of the reef or the islands proceeds, and especially when islands get broken through, sand derived from this erosion on the outer face is drifted round the islands and is to a large extent deposited on the lee side, and it is in this manner that the islands migrate across the reef flat. The surface of the lagoon reef has itself undergone erosion, and one can frequently detect a clear line of demarcation between the reef-flat and the recently deposited sand. At times the sand instead of being deposited along the lee side of an island is built out into spits that curve inwards towards each other and, on finally meeting, enclose a small area of the lagoon and convert it into a lake, the water of which, though at first salt, gradually becomes brackish and finally may be even fresh enough to drink. A series of such lakes has been

formed on the lagoon side of the island Hera-tera on the east of Addu Atoll. One point of interest in the formation of some of these lakes is that on the top of the bank, on their outer seaward side, there is a clearly marked line of deposit of rounded and water-worn masses of pumice, that almost certainly was deposited there after the great explosion of Krakatoa in 1883, that, so far as I know, being the last occasion on which quantities of floating pumice have been recorded in the Indian Ocean; if this be so, then the lake and the inner margin of the island have been formed within the last fifty or so years.

Turning now to the more northerly region in which we may expect to get evidence of the full force of the south-west monsoon, we have the atoll of Goifurfehendu, or Horsburgh Atoll, which is fully exposed to the south-west but is sheltered on its north and north-east sides by other atolls. We should therefore expect to find that it was the south and south-west sides that have been most affected, and this is clearly the case, for from these sides practically all traces of land have disappeared. Erosion has proceeded least far on the north-east side; here the island Goidu still abuts on the boulder zone, though there is clear evidence that erosion is to some extent going on, and especially so in the south of the island. Agassiz* remarks that "the southern extremity of Goidu island appears to be washing away, a small adjoining island marked on the chart has disappeared." Moresby's original chart shows two small islands on the reef in this position, but at the present day there is only one, and that too is rapidly disappearing; the outer margin has been eroded and has exposed the breccia foundation, which in one part of the reef has given rise to a line of coral "horses." On the northern reef, in spite of the protection afforded by the neighbouring atoll, South Malosmadulu, erosion is going on rapidly. Along the margin of the reef we get a well-developed zone of dead coral masses, on the seaward side of which the sloping reef platform is covered with scattered masses of dead coral, interspersed with which are scattered colonies of living Madrepore, and between the boulder zone and the islands is a wide stretch of shallow water. The islands themselves on this side of the atoll are composed of sand, and all along their faces are exposures of breccia and sandstone, this latter being partly reef breccia and partly sandstone that has formed beneath the sandy raised margins of the island; in places even the conglomerate of the old lagoon beach is exposed on what is now the seaward face of the islands. On the outer side of the islands there is an extensive exposure, now worn into a sloping glacis between tide-marks and terminating above in a small cliff; the breccia here slopes away from the reef-margin, indicating that it was originally part of the reef-flat on the inside of the boulder zone. That erosion is still proceeding in this island is shown by the formation, about the middle of its length, of a bay where the outer rim of breccia has been broken through and the sandstone formation has been washed away. The head-man of the atoll informed me that when he first came to the atoll twelve years previously this part of the island was some 40 yards wide, but at the time of my visit there was only a narrow neck of land, that at the most was only 4 or 5 yards wide, between the seaward and lagoon beaches, and it can hardly be doubted that before long the sea will have broken through completely and

*"The Coral Reefs of the Maldives," *Mem. Mus. Comp. Zool. Harvard*, vol. xxix, p. 54, 1903.

Coral growth in sheltered area of outer reef-flat on north side of Horsburgh Atoll, Maldives

Coral growth on lagoon reef on north-east side of Addu Atoll, Maldives

Coral growth on lagoon reef on north-east side of Addu Atoll, Maldives

will have divided the island into two. Where erosion has proceeded far enough, though not so far as in this bay, we find an exposure of sandstone that I attribute to the formation of a secondary deposit beneath the sand of the island; and an excavation in the middle of one of these islands clearly shows that this formation has been going on even beneath the flat central part of the island. The stratum of this deposit is horizontal, so that it has been deposited beneath the flat central part of the island, the loose sand over it having subsequently been washed away.

On the lagoon face of the same island the breccia formation has also been eroded to a smooth glacis, terminating below at low-water-level in a small cliff. On this side of the island there is another bay, and here we get an outcrop of sandstone that exhibits a slope away from the lagoon, so that this appears to have formed under the reverse slope of the lagoon mound.

The last part of the atoll that remains for our consideration is the lagoon and the lagoon reefs. As we pass from the lagoon beach of an island towards the inner edge of the lagoon-reef we find that the reef-flat slopes gradually downwards, and that there is a gradual increase in the amount of coral that is growing on it; patches of coral appear and become more and more frequent, till they finally coalesce and form the inner or lagoon reef. If now on such a reef-flat sand and mud are being deposited, owing to the erosion of the islands, the coral on the upper surface will to a large extent be killed off, the continuity of the reef will be broken and the process of destruction will gain the upper hand. The general character of such a reef is clearly shown in the north-east part of the lagoon in Addu Atoll, where erosion is steadily going on. Although the face of the reef appears to be flourishing, the reef surface is for the most part composed of dead coral-rock, scattered over which are a number of isolated colonies of coral that are either Astraeids or small colonies of the "corymbose" or basket-like type of Madrepore. With the destruction of this part of the reef, solution commences and finally the inner face of the reef becomes separated from the reef-flat by a channel, the reef-flat later, if circumstances are favourable, forming a new face. The process of this change can be well seen in the character of the lagoon reef in Horsburgh Atoll; here on the northern side, where, as we have seen, erosion is steadily progressing, the lagoon reef has become separated from the rest of the reef and now forms a narrow reef running parallel to the rest of the reef-flat. On the north-east side, where erosion is most active, though probably intermittent, this phase has been repeated no less than three times, a series of three lagoon reefs having been formed, and each in turn has been isolated from the rest of the reef by the destruction of the reef-flat and the solution of the coral rock.

Where the condition of the reef is such that death and the consequent destruction of the coral is not taking place, and where erosion has ceased, so that the reef surface is once more stable, whether this be on the outer side between the boulder-stone and the islands or on the inner side between the islands and the lagoon, we find coral flourishing and forming large expanses of profuse growth; such a condition is well seen on the north side of Horsburgh Atoll, where between the boulder zone and the islands there is a wide belt covered partly with *Heliopora coerulea* and partly with stag-horn Madrepore; and again on the inner side of the islands on the south-west side of Addu Atoll,

where acres of the reef-flat are covered with a profuse growth of stag-horn Madrepore and Astraeids. With the final disappearance of the islands and the stabilization of the reef-flat, areas such as these will be able to unite, and we shall get the condition that is present on the south side of Horsburgh Atoll. Here the reef, inside the breakers, consists of a well-marked boulder zone, along which are scattered large masses of coral torn off the reef face and flung inwards and now lying in any position. Small colonies of *Pocillopora*, Madrepore, Astraeaceae, and *Meandrina* are growing on the reef, but the predominant feature is the growth of *Lithothamnion*. A few patches of *Halimeda* and other weed are present. Inside the boulder zone is a wide belt covered by about 1 foot of water at low-water spring tides, and growing on this part of the reef are numerous colonies of stag-horn coral, with a few colonies of *Pocillopora*, *Heliopora*, Astraeaceae, and a few *Fungia*. This coral growth gradually thins out and the reef flat becomes covered with sand interspersed with patches of Madrepore; finally the inner edge of the reef slopes steeply into deep water, the face being covered with a profuse growth of Astraeids and especially with colonies of the "corymbose" type of Madrepore.

When this stage is reached we shall have returned to the condition that was present before the change of sea-level brought the reefs above water; and the Maldives and Laccadives will be represented by a series of reefs, just awash at low-water, but with here and there a few small islands, and these composed of coral boulders that have been thrown up by wave-action in situations where a cross-set of the waves increases their power, as at the entrances of the deep channels.

DISCUSSION

Before the paper the PRESIDENT (Admiral Sir WILLIAM GOODENOUGH) said: The foundations of the life work of Charles Darwin were undoubtedly laid on board the *Beagle* during the long voyage of five years which left this country just one hundred years and a few months ago. It was thought proper that one evening during this Session should be devoted to such a centenary, and the part of the work which we are going to remember to-night is that which Charles Darwin did on coral islands—a prominent part of his work. We are to hear of the coral islands of India, and we are very fortunate in having Colonel Seymour Sewell to lecture to us. He passed into the Indian Medical Service in 1908 and was appointed in 1910 Surgeon-Naturalist to the Marine Survey of India. After having worked during the war at his duties as medical officer, he rejoined the *Investigator*, and continued to serve in her as Surgeon-Naturalist until he was appointed Director of the Zoological Survey of India. His knowledge of these matters is considerable, as you will gather from the lecture I now invite him to commence.

Colonel Seymour Sewell then read the paper printed above, and a discussion followed.

The PRESIDENT: We are sorry that Sir Matthew Nathan and Dr. Stanley Gardiner are unable to be present, but Mr. Steers, who was with the Barrier Reef Expedition, is present, and I will ask him to address us.

Mr. J. A. STEERS: I did not realize when I was invited to speak this evening that I was taking part in what in effect is a Darwin centenary meeting. That however being the case, I would like to divide what I have to say into two parts.

The first slide showed very clearly the general nature of Darwin's theory. There is no need to discuss that theory now, but I think the interesting point to note is that Darwin's views have rather come back into favour. When he first published his ideas the subsidence theory was all the vogue. Later in the century investigators ceased to believe in widespread subsidence, and so other schemes were enunciated, by Sir John Murray amongst others, and Agassiz, who supported the erosion theory whereby platforms were cut along coasts and later coral grew upon the platforms. Later still, I think in 1915, Professor Daly put forward an extremely interesting theory which was alluded to indirectly this evening, namely, the Glacial Control Hypothesis. In the Ice Age the sea-level was lower and the pre-existing reefs were presumably cut down and destroyed, especially in those areas outside equatorial waters. Later, when the sea rose again, the coral was able to grow up. This may have happened more than once with the oscillations of sea-level in Quaternary time. Such a theory implies that the rivers coming down from the lands to the lagoons would adjust themselves to the new levels, and, as a result of the rise of sea-level afterwards, the valleys would be drowned to the extent of 50 or 60 fathoms.

It is a curious fact that though Darwin was an extremely careful observer, he overlooked an exceedingly important point in so far as coral reefs are concerned. He did not appear to recognize the importance of the geography of the shores at the bank of the reefs, and he overlooked especially the evidence of the drowned valleys, which are often submerged to such a depth that subsidence rather than oscillations of sea-level in the glacial period must be invoked to explain them. This point had been noticed about the same time by Dana. But this kind of evidence was not really emphasized until just before the war (and considerably more just after) as the result of the work of Professor W. M. Davis, who has shown that, so far as we can say at present, subsidence is as likely an explanation of coral reefs as any other. But I think any future work on the origin of coral reefs must take very much more account than has been done up to the present of the nature and structure of the Earth's interior. How can subsidence take place and what happens as a result?

It is obvious, I think, that coral reefs are a somewhat controversial subject, and I should like to argue with the lecturer over certain points. That however is impossible now. But there are one or two comments I should like to make with regard to what he has said. I am only familiar with the Great Barrier Reefs of Australia, and although that is called a barrier reef I do not think it is a typical barrier. Colonel Seymour Sewell referred particularly to the lowering of sea-level by about 20 feet. That is, I think, certainly very general, but so far as one could assume from the evidence in Australia it took place in at least two stages, because there you have evidence not merely of just one movement but of two, the evidence for which is found in raised beaches, coral conglomerates, and so on. But a point that interested me a great deal was that concerned with beach-sandstone. I am not going to discuss its origin, how it comes to be cemented, and other factors, but I think I am right in saying that the speaker said you must assume a certain amount of erosion to expose such sandstone. From what I have seen in Australia I should not be inclined to agree entirely with Colonel Seymour Sewell, because there are a great number of sand-cays and island-reefs in the Barrier Reefs, many of which are partly composed of lithified beach sand, which seems to indicate the reverse of erosion.

Another point which I would like to discuss is concerned with the formation of the islands round the rim of an atoll. I am under the impression that the lecturer's explanation brought in the question of lower sea-level and erosion. That struck me as extremely interesting, but I wonder if it applies always. From

what I can remember of Wood-Jones's work in the Cocos-Keeling Islands the explanation is rather the reverse of that given this evening, namely, that the island structures on top of the reefs were built up as a result of wave action.

A rather interesting point I was reminded of during the lecture was—and I do not know how it fits in here at all—that certain shallow bores which were put down at Low Islands, the headquarters of the main party of the British Barrier Reef Expedition, revealed a good deal of mud just below the surface of the reef-flat. However in any lecture on coral reefs controversy is very easy, and I do not want to be thought merely to criticize. I have been exceedingly interested in the lecture and particularly in the slides, which brought back very familiar memories. I wish to thank the lecturer very much indeed.

The PRESIDENT: There is one subject we have not yet heard anything of at all this evening, and in which we are always interested, and that is the people, who, despite the fact that we have not seen them in any of the photographs, do live in and about those islands, and of whom no one knows more than Sir Harcourt Butler.

Sir HARCOURT BUTLER: If nobody knows more than I do of the inhabitants of those places, nobody knows very much! I have never been to the Laccadive Islands, but I happened to be in the Government of India when the Constitution of those islands was formed. I remember one of the proposals in that Constitution was that it should be made a penal offence for any one to refuse to join in a rat-hunt. From time to time the island was infested with rats which simply ate up the crops. I remember the indignation of the legislative department of the Government of India, a very stately department, when it was told to put into the Constitution that a refusal to join a rat-hunt would be a criminal offence. The ultimate form adopted was, so far as I remember, "refusing to obey an order of a constituted authority."

Down in the south of Burma there is a tribe of sea-gypsies known as the Salones, some of whom live entirely in boats, some in little huts or perches on bamboo piles over the sea. They are very shy; they wear no clothes at all, and live by spearing or catching fish. They had one period of great prosperity when the *Emden* was supposed to be in those parts. The people of Mergui, the capital town of a district in the extreme south of Burma, fled into the jungles and the Salones came into the town and looted it from top to bottom. Otherwise they had very little to live on. They are a dark race, probably connected with the aborigines in the centre of Malaya. Some of them were induced to go and work on one of the islands of the Mergui Archipelago in connection with a pearl-making process, a Japanese process under which an irritant is put into the oyster which encourages it to make a pearl more quickly than it would naturally do. The pearl so produced is known as a cultured pearl. That industry was started on one of the islands, and two Europeans in charge of it took great precautions not to disclose the secret. For labourers they depended on the Salones. They could be trusted never to give anything away. They arrived naked and they worked naked. When they got their wages of seven, eight, or nine rupees a month it was such untold wealth that some lost their heads. I was told that the men bought clothes and the women bought rice. Whether that has any bearing on the old question as to which is the vainer, man or woman, I do not know. I leave you to form your own judgment. And that, ladies and gentlemen, is all I know of the people of the coral islands.

The PRESIDENT: Colonel Seymour Sewell, may I, on behalf of this audience and this Society, thank you very much for your lecture, for you have made what might be rather a technical, if not dry, subject into a very interesting one. I hope when you do go back you will take some colour plates with you, and if you are

still in England when we have in a few months' time an afternoon lecture on colour photography, I hope you will come and listen to it.

With regard to what Sir Harcourt Butler said about the Salones it may be of interest to you to hear part of a letter which I received not so long ago from the Naval Commander-in-Chief in the East Indies. He was in Mergui and wrote: "We came across a few boats belonging to the Salones or sea-gypsies. I followed two boats in my dinghy and eventually got up with them, and found the women and children almost in hysterics—crying and screeching and evidently nearly frightened out of their lives. However we made friends with them and eventually got them to the ship and gave them lots of presents. They are a curious race, living absolutely as they do in the most flimsy kind of boat, and existing for food almost solely on the fish they catch."

There are various questions which could be discussed, and I am sure that we shall not have the least objection if you and Mr. Steers sit up as late as you like discussing and arguing them—I do not say here. I have found that the various questions which a very ignorant man would put, and, from his very ignorance, most difficult questions to answer, were nearly all answered as you went on with the lecture. I was prepared to ask how soon it was in the formation of these islands that the animals came. We saw the birds. I could only suppose when you said that the islands disappear that animals, other than rats, know that it is no good going to live on them. Will you accept both from this audience and the Society our very sincere thanks for your lecture and for the extraordinary amount of real hard work which you have put into it. When you do come back again—I understand that you soon leave for further work in India—we shall be glad to see you with coloured photographs and hear some more about the reefs.

THE BRITISH ARCTIC AIR ROUTE EXPEDITION: *Continuation from the May Journal of a paper read at the Special Evening Meeting of the Society on 12 December 1931, by*

H. G. WATKINS

Fifth Journey: Angmagssalik to Ivigtut

On July 1 Scott, Stephenson, and Lindsay started to do a journey from the base to Ivigtut on the south-west coast of Greenland. They were to travel as near the east coast as possible until they reached Umivik in order to map the coastal mountains. From here they were to start across the Ice Cap to Ivigtut in order to fix its height along this line and to study the weather conditions at this time of year.

The first part of the journey as far as Umivik lay down the eastern edge of the Ice Cap, which here is high and slopes steeply down to the coast. This steep slope is badly crevassed, so that they had to keep back on the more level part of the Ice Cap, which meant that only the highest of the coastal mountains could be seen. The weather was rather warm and consequently a crust was formed which hurt the dogs' feet. In spite of this, travelling conditions were good.

From Umivik they turned directly towards Ivigtut, travelling across the highest part of the Ice Cap. They found that the height increased as they got south and reached its maximum between Umivik and Tingmiarmiut at 9200 feet. Conditions remained good throughout the journey, and on several days it was possible to use sails with a following wind. On July 25 they saw the first coastal mountains north of Ivigtut, and found them a good deal farther inland than is shown on the map, so they had to alter their course to avoid them.

They eventually left their sledges about 15 miles from Ivigtut and walked the last part over the rough Ivigtut Glacier and round the shore to the settlement. The whole journey had taken just twenty-six days, the total distance being 448 miles: an average of 17 miles a day. In spite of heavy loads the dogs were in excellent condition at the end of the journey, and as food for six weeks had been taken there were still large quantities of supplies left. There is little doubt that 600 miles could have been done in six weeks if it had been necessary. The weather was good throughout and only three days were spent in the tents owing to bad weather. There were no low temperatures on the journey, the lowest being above zero. There was a good deal of light snowfall and mist.

Sixth and Seventh Journeys: Crossing to Holsteinsborg, and Coast Journey to Julianehaab

There were also two further journeys planned for the summer: one to be undertaken by Rymill and Hampton across the Ice Cap to Holsteinsborg on the west coast; the other by Lemon, Courtauld, and myself round the south-east coast of Greenland to Julianehaab on the west coast. The party crossing to Holsteinsborg would have to go about 90 miles by sea after crossing the Ice Cap before they could reach the settlement, and it was obvious that they would have to take some form of boat with them. Eskimo kayaks seemed the best thing to use as these can be carried on a sledge without much difficulty.

For the coast journey we had two open 15-foot whale-boats. We had used them a good deal with outboard motors throughout the year in the drift-ice and had come to the conclusion that they would be excellent for coast survey in heavy pack-ice. If the ice starts pressing together owing to a storm, it is quite easy to haul these small boats out on to an ice-floe and wait for the pressure to stop before launching them again. The only difficulty was that in order to carry enough petrol for the full 600-miles' journey it would be necessary to carry such a large quantity that there would not be room for enough food for the whole journey. We saw therefore that the journey would be impossible unless we could learn to live by seal hunting in the same way as the Eskimos.

In the winter and spring it is a fairly easy matter to live by seal hunting, and white men have learnt to do this quite successfully. In the summer it is much more difficult. It is practically impossible to get near a seal in a motor boat or rowing boat, and even if the seal is shot it will immediately sink and will be lost. The only way Eskimos get seals in the summer is with the kayaks and harpoons. We had been told that white men could never learn to use kayaks safely or hunt with them. But we did not see why it should not be possible for a white man to learn to use a kayak just as well as any Eskimo, or even better. Anyhow we knew that we could not possibly do the coast journey unless we could learn to hunt seals.

So for the month and a half before the annual visit of the Danish ship two or three of us went off to an Eskimo settlement about 5 miles from the base in order to learn to use the kayak.

It is a very narrow canoe about 19 feet long, made of a light wooden frame, covered with waterproof sealskin. The man sits in a small circular hole, wearing a waterproof coat of sealskin, which has a hood fastening tightly round the face. Waterproof gloves are worn and the sleeves of the coat fasten tightly over them. The bottom of the coat fastens over the rim of the circular hole in which the man is sitting, so that he keeps perfectly dry, even if a wave sweeps right over him.

About 90 per cent. of the Angmagssalik Eskimo men end their lives by drowning in the kayaks through being overturned by an attacking seal or walrus, or by a wave. A kayak is a tight fit and it is impossible to get in or out quickly. The sensible Eskimos have learnt a special trick which saves them if they are overturned. This trick is to roll right round with the kayak and come up the other side. About one in every four of the Angmagssalik men can do this. Once a man can do this roll with absolute certainty, it means that he is safe to hunt alone, as he will be able to get up again if he is knocked over. I knew that I should have to hunt alone on the coast journey, and I saw that it would not be safe unless I could learn to roll the kayak. It turned out not to be as difficult as it looked, and eventually six of us learned to roll, and one or two of us learned to do it without the use of the paddle (with the hands only). This is much more difficult and can only be done by a few Eskimos, but it is essential for safe kayaking, since the paddle might be lost in a fight with a seal; then, if you could not get up with the hands only, you would drown.

The Danish ship *Gertrud Rask* arrived at the base on August 12, and D'Aeth, Bingham, Wager, Chapman, Riley, and Cozens returned with this ship to

Denmark and thence to England. Scott, Stephenson, and Lindsay had already reached Ivigtut, so that there were only five of us left at the base: Rymill and Hampton who were to cross the Ice Cap to Holsteinsborg; Lemon, Courtauld, and myself who were to do the coast journey to Julianehaab. On August 13 we took Rymill and Hampton over to the glacier in our boats and left them there for the start of their journey with their sledges, dogs, food, and kayaks.

On August 15 Lemon, Courtauld, and I started off on the journey to Julianehaab. We had with us two 15-foot whale-boats driven by 4-h.p. Johnson Sea Horse outboard motors. These boats had belonged to the *Quest*. The bows were copper-sheathed against new ice. The bows of one of the boats were decked over so as to have some shelter for our stores; a mast was also fitted so that we could sail if necessary. We took a large quantity of petrol for the motors, and this occupied most of the space in the boats. Besides this we took three kayaks and all the kayak hunting equipment, rifles, shotguns, and ammunition. We also took two small sledges in case we lost the boats and had to cross the Ice Cap; and winter hunting gear so that if necessary we could spend the winter on the coast. We took some emergency provisions in case we had to cross the Ice Cap, and a little porridge and sugar; but we knew that we should have to rely almost entirely on seal meat for our food.

We had planned to survey as far as Umivik, a distance of about 140 miles from the base, and from there to travel fast to Julianehaab. To the south of our base the Ice Cap comes down to the sea in many places, and as far as Umivik there is practically no coastal mountain belt. There the sea is covered to a large extent by pieces of glacier as well as the ordinary pack-ice.

From the base to Umivik we travelled slowly, an average of about 5 miles a day. Lemon was doing the plane-table survey and Courtauld the astronomical observations.

Luckily the weather for the first fortnight of the journey was good and they were able to work fast, landing on most of the high points and islands. The main details of this coast had been mapped by a Danish Expedition under Commander Gustav Holm, but we had seen from our aeroplane flights that we should be able to make considerable additions to the maps between our base and Umivik. We found that between Pikiutdlek and Umivik there is an island 40 miles long, which was shown as the coast-line on the map, but we found that it is entirely separate from the mainland, and has two ice caps of its own.

While Lemon and Courtauld were surveying I spent my time hunting in my kayak in order to keep us supplied with food. In the time past the Eskimos used to hunt with the harpoon from their kayaks; seals were plentiful and it was not very difficult. Unfortunately, owing to the large numbers of seals killed every year by the European sealing ships, they are now becoming scarce and the Eskimos are using other methods. Some use a large-bore rifle. This of course kills the seal, and it sinks; it is however sometimes possible to get near enough to harpoon it just as it is sinking. Other Eskimos use a light rifle; this does not always kill the seal, but wounds it. Then it can be harpooned when it is struggling about. Other Eskimos use a shotgun and try to blind the seal and then harpoon it. Owing to the fact that they have not any standard method of hunting a seal, they lose about four out of every five seals which they hunt.

Watkins in kayak fitted for seal hunting

Finish of a kayak roll

Camp on the journey to Ivigtut

Camp on the journey to Tegut

I spent the first fortnight of the journey in shooting ducks, guillemots, and gulls from my kayak in order to keep us supplied with food. But I also spent a great deal of the time in watching the summer habits of seals. I knew a good deal about their habits before, but before I could hope to get seals regularly in my kayak I must be able to tell at 100 yards the type of seal, whether it was young or old, and what it was doing, whether playing or travelling or resting. Each requires a different method of hunting. I soon came to realize that the shotgun and harpoon method was the only sure way to get a seal from a kayak.

The actual hunting of the seal is a long and complicated matter, and unless you are a very experienced hunter you will probably only get near enough to have a shot at one out of every six seals that you see. After a seal has been shot with the shotgun it will dive and, depending on what type of seal it is and how old, it will remain down for anything between five minutes and twenty minutes. With experience one knows almost exactly when it will come up, and before it dives again you have to try and harpoon it. The head of the harpoon sticks in the blubber of the seal, and then it starts struggling to try and get away, and will even try to attack the kayak. The Bladdernose seal will sometimes try to rip a hole in the underside of the kayak, and many Eskimos are killed in this way. The hunter holds the end of the harpoon line and tries to pull the seal in close enough to kill it with his lance. I once struggled with a seal for about one and a half hours after I had harpooned it before I could get it close enough to lance it and kill it. This seal weighed over half a ton. During the whole journey I got seven seals and sixty-one birds in my kayak. Of course I was only hunting occasionally, a total of about ten days' seal hunting on the whole journey. Apart from this we got a good many birds as we were going along in our boats.

We had sent some Eskimos from our base to Umivik with petrol, so that we could fill up for the last 450 miles of our journey. When we reached these Eskimos we spent a week with them mapping the fjord and shooting birds to bring in a supply for the rest of the journey. The Eskimos were very disappointed, since they thought that we should arrive with large supplies of sugar and viands and other civilized food. Actually by this time we had practically nothing left, and were living almost entirely on seal meat, bird meat, and berries. A diet consisting of seal meat and fat is the most satisfactory I know. You do not feel you want anything else.

We left Umivik on September 8. We had no more surveying to do, but had planned to travel as hard as we could to Julianehaab. The coast south of Umivik is much more mountainous, and there is a fairly wide strip of mountainous country between the Ice Cap and the sea. Since the Danish ship had not arrived at our base until August 12, we had been forced to start rather late in the year, and we found that south of Umivik there was practically no drift-ice. This meant that there was a good deal of swell since there were no floating ice-pans to keep the sea calm. Our boats were excellent for travel in drift-ice, but they were too small and overloaded for travel in a rough sea, and we had a good deal of difficulty.

At Akorninarmiut we had a bad delay, being caught out in an extremely bad sea; the engines broke down owing to the waves breaking over them, and it was with the greatest difficulty that we managed to row through a line of

tottering icebergs to a small fringe of rocky islands where we camped. The weather remained bad for a considerable time; we were unable to get the engines running really satisfactorily, and one would not work at all. We sent out a wireless message saying that we might be forced to spend the winter near this place or to cross the Ice Cap to Igaliko. Either course would have been possible and not necessarily difficult. We had brought with us plenty of ammunition, harpoons, etc., so that we should have been able to get plenty of food during the winter; we also had with us small sledges, primus stoves, and an emergency supply of pemmican for a possible crossing of the Ice Cap. Luckily however we did not have to take either of these courses. We decided to abandon one boat, leave all unnecessary gear behind, and load our stores on the other boat. During the next short spell of fine weather we were able to carry on down the coast. Just past Tingmiarmiut we had the worst delay of the whole journey, due to bad gales which kept breaking up the front of the big Puisortok glacier, and covering the sea with closely packed glacier ice which made boat travel impossible; we were also delayed in this place by fog and engine trouble; it looked as if we should almost certainly have to spend a year here and go on the next summer when the weather was better. It was a good place to stay in and hunting conditions were excellent. During our stay there I managed to get several seals from my kayak, and Lemon and I were able to lay in a large supply of birds; however we were not forced to stay there. While I was hunting Lemon and Courtauld worked every day on the engine and were eventually able to repair it. During the next spell of fine weather we were able to make a final dash for the safety of Prince Christian Sound, the narrow sound which leads through from the east coast to the west coast just north of Cape Farewell. For this last part of our journey we had clear calm weather, and occasionally were able to travel all night. The coast here is more precipitous than in the north and the fjords narrower and longer; in most places there is a fairly wide mountain belt between the Ice Cap and the sea.

There was no drift-ice whatsoever, and we were only troubled occasionally by floating blocks of glacier ice and by icebergs. About 30 miles north of Prince Christian Sound we met three Norwegians who had been left there for a year to hunt. We had taken refuge in a fjord from a bad gale which had sprung up suddenly, and we spent three days with these Norwegians. They were very good to us indeed, making us completely at home and giving us as much to eat as we could wish in the way of sugar and bread and such things as we had not had for a long time. They told us that the hunting was bad and that they did not like the place at all; when we arrived they had not had any fresh meat for a long time and were very glad of the seal meat which we were able to give them. They told us that there were no seals in this fjord, but actually in one afternoon I saw seven from my kayak, and it was simply owing to the fact that they did not have kayaks and did not understand Eskimo hunting methods that they were unable to get fresh seal meat.

We met the first west coast Eskimos about 5 miles north of the entrance to Prince Christian Sound, but it was not until we got to the western end of Prince Christian Sound that we reached the first big settlement, Augpilagtok. We had arranged by wireless that some petrol should be waiting for us at this place, but owing to a muddle in the telegram we found no petrol, but a large

depot of paraffin. Luckily we had just enough petrol left to carry us on to Nanortalik, the big settlement south of Julianehaab. Here there were many boats which could take us to Julianehaab; and here we met Dr. Rasmussen and the members of his expedition who had just returned from their journey to the east coast. Dr. Rasmussen was extremely kind to us, helping us in every way, and took us as guests on his boat to Julianehaab.

We had expected to hear at Julianehaab that Rymill and Hampton, who were crossing the Ice Cap from our base to Holsteinsborg, had already arrived, but they had not done so. We decided therefore to go on up the coast as far as Holsteinsborg to meet them, realizing that they might be having considerable difficulty with the last part of their journey. With the very kind assistance of the Governor of South Greenland we were able to charter a small boat and travel in good time to Holsteinsborg, where we met Rymill and Hampton, who had arrived two days before us.

Crossing the Ice Cap from the Base to Holsteinsborg

Rymill and Hampton left the eastern edge of the Ice Cap on their 450-mile journey on 12 August 1931. They had with them two sledges and two kayaks. The kayaks were for completing the last 100 miles of the journey down a long fjord from the western edge of the Ice Cap to Holsteinsborg. We had been told that it would be quite impossible to carry kayaks on sledges on a long journey since they would be broken whenever the sledges overturned or be eaten by the dogs. We did not see why this should be so, and we realized that if we could show that it was possible to carry kayaks on a sledging journey it would open up new possibilities in the way of Arctic transport. Rymill and Hampton rigged up a special framework on top of the sledges to keep the kayaks out of reach of the dogs and to protect them if the sledges should overturn, and in this way they were able to carry them the whole way across Greenland without any damage.

They found the eastern edge of the Ice Cap as far as the Big Flag extremely wet and difficult for travel. Just near the Big Flag they saw a polar bear wandering along on the Ice Cap. On several occasions we came across the tracks of these animals, sometimes as much as 30 miles inland. They probably travelled from the head of one big bay to another across the Ice Cap. The first part of this journey they did in extremely good time, the weather and surface conditions being good, and they were able to average as much as 23 miles a day for as long as a week at a time. They had an aeroplane compass mounted on the back of the sledge, and they steered their course in the same way as an aeroplane. This saved the frequent stops to take bearings which are usual on a sledge journey.

On September 4 they saw the first mountains of the west coast and soon began to get into difficulties. All the snow was gone from the ice and the country all round was in big ridges, with crevasses on the top and rivers and lakes in the valleys between. Luckily most of these lakes were frozen, and they were able to cross with their sledges and dogs. On one of these lakes Rymill's sledge went through the ice into 3 feet of water, and everything got soaking wet. They frequently had to wade across rivers carrying their gear and leading the swimming dogs across one by one. Owing to the appallingly rough nature of the country they soon saw that sledging was useless, and they decided to

abandon first one sledge and then the other and carry everything for the last 40 miles of the journey to the coastal mountains. Relaying all the stores they eventually reached the coastal land on September 30. Unfortunately the weather had turned cold and most of the rivers and lakes on which they had hoped to use their kayaks were frozen. Occasionally they were able to use their kayaks on some of the larger lakes and the swifter rivers. They had a narrow escape on one of these rivers, when both their kayaks were overturned by the swift current and Rymill was swept under the ice upside down in his kayak; there was an open stretch of water a little farther on, and he was fortunately able to cling on to the ice and save both himself and his kayak.

On October 4 they reached the head of South Strom Fjord with their first load. The next day, while returning with some more loads, they were surprised to see a fishing boat with some Eskimos in it. These had been sent out by the Governor of Holsteinsborg, who had been worried as the party was overdue. Actually, when they were met they still had food for ten days, and after that, if necessary, they could have lived by hunting, for there were plenty of seals in the fjord and plenty of caribou in the hills. The whole journey had taken sixty-five days, much longer than they had anticipated, and during the last part of the journey they were on very short rations. On October 20 they arrived at Holsteinsborg, and two days later we met them there.

Throughout the year we had had the very greatest help from all the Danish authorities in Greenland. At Angmagssalik the Governor, Pastor Rosing, and the wireless operator had done their utmost to help us, and it will never be possible to thank them enough for all their kindness. During the time we spent in Greenland we saw a great deal of the way in which the Danes are looking after the Eskimos. It would be impossible to praise their rule too highly. In East Greenland their policy is to preserve the country first and foremost for the Eskimos, to keep white people from coming in, and to keep the Eskimos from becoming dependent upon white people. They have succeeded admirably, for the Eskimos still live almost entirely by hunting, are practically free from European diseases, and unspoilt by civilization—unlike the Eskimos of Labrador, who suffer from all kinds of white diseases, and who unfortunately sometimes get drink on board the schooners which come to their shores during the summer fishing season. It is earnestly to be hoped that the Danes will continue their policy unchanged. It will be a bad thing for the Eskimos if white hunters are ever allowed to settle permanently anywhere along the east coast between Scoresby Sound and Cape Farewell. At the present time the Eskimos know that if they have a bad year's hunting in their main settlement they can always move up or down the coast the following year and get as many bears and seals as they could possibly wish for. With the permanent presence of white hunters game would become scarce and the Eskimos would soon be harmed.

Incidentally there are not enough foxes to make trapping along this coast worth while.

APPENDIX I.—REPORT ON FLYING WORK

FLIGHT-LIEUT. N. H. D'AETH, R.A.F.

Personnel and Equipment

The flying personnel of the expedition consisted of myself, lent by the Air Ministry, in charge of flying, and Hampton as second pilot and engineer. I was the only pilot with experience on seaplanes, but in addition to Hampton, Watkins, Rymill, and Cozens were all qualified land-plane pilots. Unfortunately, as there was very little time to spare, and as conditions were not favourable for carrying out flying instruction owing to ice, I was unable to give Hampton any dual-control experience, and so he got no flying while the Moth was on floats.

The equipment consisted of two D.H.60x Moths with Gipsy 1 engines, constructed by the De Havilland Aircraft Co., Ltd. G–AAUR had special locker accommodation for carrying a rifle and all the necessary emergency gear that had to be taken on long-distance flights, also special fittings for taking vertical and oblique photographs. She had two undercarriages: one with floats designed and built by Messrs. Short Bros., which were specially strengthened for emergency landings on snow or ice. Luckily we never had to test their efficiency in this respect. For winter flying she had a standard Canadian type ski undercarriage. G–AAZR was only ordered about a fortnight before the expedition left England, and was standard in every way. She was only fitted with a ski undercarriage. Both aircraft had *coupé* heads, exhaust-heated cockpits, and extra fuel tanks giving an endurance of about seven and a half hours, or approximately 560–600 miles in still air.

Spares were limited to a certain extent by lack of money, but in addition to one float and one ski undercarriage complete, a very comprehensive list was made out by Hampton, and events proved that everything of any importance was included. All petrol and oil was supplied by the Asiatic Petroleum Co. G–AAUR, all spares, and about half the petrol and oil was shipped on board S.S. *Quest*, while the rest came out in the Danish Government steamer *Gustav Holm* later.

Summer 1930

The main summer programme consisted of photography of the coast from Angmagssalik Island north as far as Kangerdlugsuak Fjord. In addition, photographs were to be taken of Sermilik Fjord if time permitted, but this was not important, as it could be done during the following summer. Besides photographic work some reconnaissance flights were to be made over the border of the Ice Cap to find the best way through the crevassed area. Actually all the photography was carried out with the exception of the portion of the coast from Angmagssalik to Björne Bugt. This was omitted, as it was found to be a mass of islands, and to photograph it sufficiently well to be of value to the surveyors would have taken all the summer. Under these circumstances, and as the photography of the coast farther north was considered to be of more value, it was decided to omit this part. The reconnaissance flights were carried out, Watkins, Scott, and Rymill being the passengers. They proved to be of considerable value to the party that left a few days later to establish the Ice Cap station.

The *Quest* arrived at Niarunak, where the base was situated, on July 27, and as soon as she had been unloaded and the deck was clear, Hampton, Cozens, and I started to uncrate, assemble, and rig G–AAUR. She was uncrated and assembled on board, and then towed ashore and rigged on the one comparatively smooth beach in the vicinity. The first flight was carried out on August 3, three days after starting work. All this time the weather was uniformly fine with clear

blue skies or a trace of cirrus, so that conditions for photographic or reconnaissance flights were ideal. Yet in spite of these perfect weather conditions, flying from the ice-filled waters of East Greenland in a single-engined aircraft was, of necessity, a severe strain. Implicit faith had to be placed in the engine, as any forced descent away from the base would be almost certain to result in a crash with serious results. However reliable an engine may be—and the Gipsy is world-renowned in this respect—and however well maintained, it is impossible to expect it to run for ever without some slight trouble, just as it is impossible to expect a car to run indefinitely without a minor breakdown. Not only is the possibility of an engine failure always on the pilot's mind, but also the risk that the ice may close in after he has left for a flight, so that on return he may be unable to find any clear space large enough to land in.

From August 3 to 9 flights were carried out daily in perfect weather conditions, chiefly for photography of Sermilik Fjord and the coast round Angmagssalik Island. Three reconnaissance flights were also carried out over the border of the Ice Cap. We soon found that we had been lucky in the selection of our base, as there was always some place clear enough to fly from, while other fjords that were flown over were almost always filled with pack- and drift-ice. On August 9 the *Gustav Holm* arrived with the other Moth, G–AAZR, which was got ashore but not uncrated.

On August 11 the *Quest* left for the north for the survey of the coast as far as Kangerdlugsuak Fjord. As soon as we left our base we were again struck by the lucky choice of the site, as we had great difficulty in finding any place suitable for flying from. On August 14 we arrived at Kangerdlugsuatsiak, and in the afternoon I took G–AAUR off in moderately clear water for a reconnaissance flight. Watkins was the passenger. This flight only lasted three-quarters of an hour, but on return I found that the ice had closed in so much that there was considerable difficulty in landing. Even in the most open place I could find in the fjord there was barely enough room to land, and the fact that no damage was done can only be ascribed to good luck. This experience was most disheartening, as it appeared that unless we found some fjord particularly free from ice it would never be safe to fly. On August 15 the *Quest* left for the north again, but that evening, for the first time since we had landed in Greenland, the weather looked so threatening that the Captain decided to take the ship into the nearest fjord for shelter, in case of a storm. This was an unnamed fjord in lat. 66° 20′ N. Here again we were very lucky, as about a mile from its head we found a large lake about 3 miles long, ice free, and in every way suitable for a seaplane base. On August 17 the ice in the fjord was open enough for the Moth to be taken off light and without a passenger, so I took her up to the lake, where she was secured. From here two flights were carried out on August 18, one on the 19th, and one on the 20th, and photography of the coast was completed from Björne Bugt in lat. 66° 05′ N., to Langeön, in lat. 67° 04′ N. On August 20 the *Quest* left for Kangerdlugsuak Fjord, and arrived there on the 23rd. At first it appeared that the fjord would be quite impossible to fly from owing to the large amount of ice always present, but after cruising about for seven days a site was at last found that was clear enough so long as flying was only carried out when the tide was on the ebb. I therefore took off as soon as conditions were favourable on the 29th, with Watkins as passenger, to carry on the photography of the coast to the south, and of Kangerdlugsuak Fjord. During this flight we observed, about 50 miles to the north of the fjord, a range of mountains towering above the remaining ranges, and of a height that I should estimate as from 12,000 to 14,000 feet. On return from this flight we saw that Mikis Fjord, to the east of Kangerdlugsuak, was very free from ice, so after landing and being hoisted on board, we proceeded there in

the *Quest*. On arrival there we found that conditions were as good as we had hoped, and generally that the fjord was very suitable for flying from. On the following day another flight was carried out, and the photography of the coast and Kangerdlugsuak Fjord was completed. We also took some photographs of the new mountains seen the day before.

On August 31 Watkins and I returned to the base in G–AAUR after a flight of four and three-quarter hours. A few more local flights were carried out, and then on September 15 I left for the Ice Cap station, and as all the summer programme had been completed, G–AAUR was got ashore. Hampton then built a hangar out of the aeroplane packing-cases, which was large enough for the two Moths folded, fitted the ski undercarriage to G–AAUR, and erected and rigged G–AAZR ready for winter flying.

A brief summary of the air work done in the summer of 1930 follows. Twenty-three flights were carried out in the forty-four days available, totalling 32 hours 15 minutes. Nine of these, making up 18 hours 20 minutes, were photographic, during which flights approximately 450 plates were exposed, covering the whole coast from Björne Bugt in lat. 66° 05′ N. up to and including Kangerdlugsuak Fjord in lat. 68° 10′ N., as well as some parts of Sermilik Fjord and Angmagssalik Island. Throughout the whole period there were no accidents, the programme was carried out almost to plan, and the season can be considered as most successful.

Winter 1930–31

The winter programme was very ambitious, and unfortunately could not be carried out. I wish to make it quite clear that the failure to carry it out was due to the unexpectedly bad weather and the large number of gales for which, in view of the weather summary supplied by the Meteorological Office before the expedition left England, we were quite unprepared. But for this the whole programme could have been carried out as planned.

It was intended that the most important part of the winter programme should be a flight by both Moths from Angmagssalik to Winnipeg and back by way of Godhavn, Cumberland Peninsula, the western shore of Hudson's Bay, and Port Nelson. In addition to this flight some trips were to be made to the Ice Cap station to drop luxuries and letters when sledge travel was difficult; if possible, to land at the centre station and exchange personnel by air. Thirdly, to take photographs of the inside of the Coastal Mountain Belt. As will be seen, the whole of this programme failed.

The winter was chiefly remarkable for the large number of Föhn gales, which first broke up the new ice as soon as it was formed, and then raised large wind-drifts on the surface of the Ice Cap, so that landing there was out of the question. As these gales, which occurred periodically from October till April, were quite impossible to forecast by ordinary methods, it was dangerous to carry out long flights away from the base, or to leave aircraft moored out on the ice unless it was absolutely necessary. Owing to the gales the ice in the fjord did not become safe for flying from till December 19, when the first flight on skis was carried out. This flight was for reconnaissance purposes. Even at this time the seriousness of the gales had not been properly appreciated, and risks were taken that would have been considered criminal later. On 1 January 1931 Cozens took G–AAUR to Tasiusak to make various necessary purchases from the store, and owing to the short hours of daylight was not able to return the same day. The Moth had to be secured out on the ice. Next night a gale sprang up suddenly and blew for about thirty hours. In spite of all efforts on the part of Cozens, assisted by Pastor Rosing and many natives, she was very seriously damaged, at first it was

feared beyond repair. However, Hampton flew over in G–AAZR, and after inspecting the damage, decided that he could carry out repairs in time for the Canada flight. He and Rymill, who was also to have been one of the crew for the long flight, went to Tasiusak, and started work on January 19. Their work was beyond praise. Working about ten hours a day in temperatures round about zero, without a workshop and hampered by shortage of some necessary spares, they carried on cheerfully and without complaint for two months. They repaired all parts possible with the spares available, and when these were finished constructed a new tail plane and elevator spar from driftwood which was obtained from a native and tested before use. No drawings were available, but the other Moth, G–AAZR, was flown over, and measurements taken from her. Throughout this whole time they were ably assisted by the native Yensimile, and at times by other natives. G–AAUR was finally finished and flown successfully on March 18. The repair, especially under the circumstances, was an astonishing piece of work. By this time, as the gales showed no sign of stopping, we were reluctantly obliged to abandon the long flight. Coming on top of the accident to G–AAUR, another accident occurred to the other Moth on February 26, while taking spares over to Tasiusak. Cozens was flying, as I was laid up with a broken arm. On landing on the fjord he hit an ice hummock which was buried in deep snow and was not visible from the air. She was damaged quite seriously. Hampton undertook repairs to this second aircraft and again, by hard and excellent work, had her finished and flying by April 30. By this time the main part of the winter programme had had to be abandoned, and as it was quite impossible to land on the very rough surface of the Ice Cap the relief of the station by air had to be abandoned too.

What flying was carried out during the winter consisted chiefly of ferrying trips to Tasiusak with spares for the repairs of the aircraft. A few flights were carried out in an attempt to locate the Ice Cap station to drop luxuries and letters there, and also a few photographic flights. All attempts to find the Ice Cap station failed, and I propose here to give some reasons to account for this. Flights always had to be made on bright sunny days, which we knew were not satisfactory. The reason why we had to fly on such days was that if the sky was overcast, the clouds almost always came down to the surface before the position of the Ice Cap station had been reached. The result of flying in the bright sunny weather was that the wind drifts threw large black shadows on the white snow surface, so that to distinguish anything in this maze of deep black and brilliant white was almost, if not quite, impossible. The winds over the Ice Cap were found to vary a great deal both in direction and strength at different heights, thus complicating the navigation considerably; but this should have caused no serious trouble if the station had been clearly visible. I was surprised and worried at the continual failure to find it, as I could see no reason for the failure if sufficient trouble were taken, as I knew that it was. Later, when we learnt that the station had become completely drifted over, it seemed reasonable to suppose that on at least some of these flights the Moths had passed close to it, and that it had not been seen only because it was not visible. On May 2 the weather was fine and clear, so I took G–AAZR in to the Ice Cap, Riley being the passenger, to look for Watkins's party, who were on their way to relieve Courtauld. At this time considerable excitement was being displayed at home about the latter, and against our wishes and advice a large aeroplane was being sent out to search for him. As this had all happened after Watkins had left the base, we wanted to drop him a letter with all this information. On this flight, for the first time since the beginning of the winter, we found the surface of the Ice Cap smooth; there were no shadows and no wind. It seemed that we were bound to find the sledge party, but when we were about 65 miles

Air-photograph, 10,000 ft. H. G. W.

Island discovered on coast journey between Umivik and Pikiutdlek

Sledging on wet sea-ice in spring

Umivik, looking south-west

Air-photograph, 10,000 ft. H. G. W.

Umivik, looking south-west

Air-photograph, 10,000 ft. H. G. W.

in we ran into fog and had to turn back. After this flight low clouds made the weather unfit for flying until May 6, when Captain Ahrenberg, in the Swedish Junkers SE-ACK, arrived at the base. There is no need here to comment at length on his excellent flight from Malmö, made almost at a moment's notice, as it had no bearing on the air work of the expedition. It is sufficient to say that it was a very fine effort. Soon after he arrived he took off again with me as second pilot, and we flew in to try and find either the sledge party or the station. Conditions were perfect, but we failed to find either. Again, the next day, May 7, we flew in in perfect weather conditions, and when about 90 miles from the Big Flag I saw a sledging party about 5 miles south of us. We closed them, and found them to be Watkins's party on their way back to the base with Courtauld. After this flight the weather again broke, but as soon as conditions were good enough, Captain Ahrenberg left for Sweden *via* Tasiusak and Reykjavik. One or two photographic flights were attempted after this, but it was found that the Moths could not climb high enough to get photographs of any value of the inside of the coastal mountain belt. Very soon the ice became unsafe for flying.

A summary of the winter air work is as follows : forty-nine flights were carried out, totalling 46 hours 50 minutes. These flights consisted of ferrying trips, reconnaissance, and photographic work. In addition, a few local flights were made and some Eskimos given trips. This was disappointing, though much valuable information was gained. The gales, short days, bad light, and the fact that it was never safe to leave aircraft secured out on the ice, prevented all long flights and curtailed local flying. In fact, in view of the unexpectedly bad weather conditions it is difficult to see how any more work could have been carried out, even if there had been no accidents. The outstanding achievement of the winter was the excellent work of Hampton, who was assisted for a large part of the time by Rymill. That we were only twenty days without either of the aeroplanes serviceable reflects the very greatest credit on them.

Summer 1931

The programme for the summer of 1931 was also ambitious. In the first place the photography of Sermilik Fjord was to be finished as far as the ground survey had gone, and then the coast from Sermilik to Umivik was to be photographed prior to the coast journey and survey which was to take place at the end of the expedition. All this photography was finished. The final flight of the expedition was to have been over the whole route from England to Winnipeg and back in a large aeroplane which, we had been informed, had actually been promised for the purpose. When the time came, this aeroplane was not forthcoming, so the flight could not be made.

Owing to the fact that the remaining photographic work could be completed in two flights, no great hurry was made to shift G-AAZR from skis to float undercarriage. Also, as only one float undercarriage was available, we decided to prepare G-AAUR for shipment home. While fitting the float undercarriage to G-AAZR, we were finally informed that the large aeroplane would not be available, so Watkins, Hampton, and I went into the question of a flight home over that portion of the route in the Moth, to gain experience of general conditions, landing facilities, and fuelling arrangements. After a full discussion we decided that such a flight was eminently practicable and that the Moth, with her extra fuel tanks, was well suited for it. We therefore overhauled G-AAZR carefully, fitted various special navigational instruments, arranged to receive meteorological information throughout the flight, and generally made all necessary arrangements. After doing all this we were very surprised and greatly

disappointed to learn that the Committee could not see that the flight would forward the aims of the expedition, and refused to grant permission for it to be made. This, after their failure to produce the large aeroplane promised, was most disheartening. In view of this decision, all that remained to be done was the photography. Ice conditions in the fjord were bad till July 20, when I left with Watkins to undertake the photography of the coast as far as Umivik. This flight was successful, and on it we discovered, between Pikiutdlek and Umivik, an island about 40 miles long which had previously been charted as part of the mainland. Two days later I went up again with Cozens and completed all the photography that was to be done. Only two flights, totalling seven hours, were carried out, both for photographic purposes.

Summary of Air Work for the Year

During the whole expedition seventy-four flights were made, totalling 86 hours 5 minutes in the air. Of these, twenty-five flights totalling 39 hours 15 minutes were in the summer from the sea, while the remaining forty-nine, of 46 hours 50 minutes, were carried out in winter from the ice. It is of special interest to note that nearly twice as many flights were made in winter as in the summer. During the year the coast was completely photographed from Umivik to Kangerdlugsuak Fjord, including the two large fjords of Sermilik and Kangerdlugsuak, but excluding the small portion from Cape Dan to Björne Bugt: it was found impossible to photograph this with sufficient accuracy in the time at our disposal. This was all the photography which it was originally planned to do, and the fact that it was completed can be considered as most satisfactory. During the summer flights, several new islands and one range of high mountains were discovered.

During the winter, except when a gale was blowing, it was found possible to fly whenever necessary, and thanks to the *coupé* heads and heated cockpits no discomfort was experienced from cold even when flying over the Ice Cap. Of course great care was necessary in the selection of suitable clothing. Throughout the whole period there were only twenty days when both planes were out of action, which speaks well for the excellent work of Hampton, who was assisted during the worst period by Rymill. The aircraft behaved splendidly all the time, even in the coldest weather, and on no occasion did flights have to be abandoned on their account. During the flights, and in fact during the whole time, a large amount of valuable information was collected, but as it is mostly of a highly technical nature it is not included here.

That no long-distance flights over the whole, or any part, of the route were carried out can only be regretted, as the failure to carry them out means that the work of the expedition is incomplete. The failure to carry out a flight in the winter, as had been hoped, was due to the unexpectedly bad weather conditions which would have made such a flight in an aircraft of the power and endurance of the Moths hazardous, which was against the aims of the expedition. The fact that no flights were carried out during the summer was, as has been stated already, due to circumstances beyond the control of the expedition.

The East Coast of Greenland as regards flying

Owing to the large amount of ice always present in the waters of the east coast of Greenland, and the rapid movement of this ice due to change of wind or tide, the fjords can be regarded as entirely unsuitable for permanent, or even temporary, bases for aircraft. There are however two lakes, one at Angmagssalik in position 65° 40′ N., 37° 32′ W., and one at the head of an unnamed fjord in position 66° 21′ N., 35° 00′ W., both of which are in every way suitable for the

largest types of flying boats or seaplanes. The former is approximately 2¾ miles long by 1 mile broad, and the latter about 3 miles long by ½ mile broad. If operating from these lakes in the summer, there is no ice to cause trouble, and never enough sea to worry a seaplane. In both lakes there are beaches suitable for beaching an aeroplane for overhaul or repair, and the bottom affords good holding ground for anchoring. The weather during the summer is almost always fine, warm, and very clear, with practically no wind, and flying conditions are generally excellent. Fog, for which the coast has a bad reputation, is scarcely ever encountered except for a period of about ten days when the ice is breaking up in the spring. Otherwise, though low fog is often present over the pack to seaward, it hardly ever reaches the coast. However there is still the risk of a forced descent away from the base which would have very serious results. This can be overcome by having a multi-engined aircraft that is capable of flying with one power unit completely out of action. It would seem therefore that given a multi-engined aircraft operating from one of the lakes mentioned above, summer conditions on the coast could hardly be improved on.

In the winter conditions are not so suitable owing to the large number of Föhngales, most of which reach force 12. Again, the fjords are unsuitable for aircraft bases, for if the freeze-up takes place when they are full of pack-ice the surface will be too rough for flying all the winter. But here also the lakes are absolutely suitable, as they are bound to freeze over with a smooth surface, and, being fresh water, will freeze over much sooner than the sea. On an average, if using the lakes, there would probably be about five weeks in the autumn during which flying could not take place while the surface was freezing over, and about six weeks in the spring while the ice disappeared. Apart from the gales, and in spite of the short days, the winter flying conditions are good. There is little snow, practically no fog, and the temperature on the coast seldom falls below zero. There is almost always some fjord smooth enough to land on in case of a forced descent, and if a forced descent did have to be made it would be possible to walk to some inhabited place if the necessary emergency rations and camping gear were carried. But though in this way the winter conditions are better than the summer, the prevalence of the Föhngales means that long-distance flights to or from any one base on the coast are out of the question. Even if an aeroplane were large and powerful enough to fly during one, drift-snow reduces the visibility to a few yards. These gales at present seem impossible to forecast as the barometer makes no move till they have commenced, but some way may be found when the meteorological records of the expedition have been carefully studied. There is every reason to believe that the gales are very local, and only occur when the mountain belt between the Ice Cap and the sea is very narrow. This is borne out by the fact that at Tasiusak there were only about one-third as many as at our base, and that they never reached nearly the same velocity. I am sure that an aeroplane flying over Greenland and not landing would not be worried in the least by passing over one. It is also probable that, if there was a base at each of the lakes mentioned above, it would be possible to land at one even if a gale was blowing at the other.

Use of Aircraft on Arctic or Antarctic Expeditions

There are two main uses for aircraft on expeditions of this sort. These are, for the reconnaissance of unknown country generally, including photography; and, especially in the Antarctic, for depot laying and supporting sledging parties. They can, of course, be put to many other uses, but the two mentioned are by far the most important. For these two jobs, two entirely different types of aircraft are required, so each will be discussed separately. In the first case, a small

aeroplane needing the minimum crew and handling party to operate it is essential. It would only be required for comparatively short flights where accurate navigation would not be necessary, and one reliable engine would be sufficient. However, it must be capable of carrying a moderate load in the way of emergency gear in case of a forced descent, and though our Moths were very useful, slightly more power would have been an advantage. The uses to which such aircraft could be put were well illustrated on this expedition. Before both the northern and southern coast journeys the part to be surveyed was flown over and photographed. By this means it was seen where the existing maps were most incorrect. Any new features were specially noted, and the photographs proved most useful to the surveyors for filling in detail. The Moths were also found useful for finding the best way through the crevassed area at the border of the Ice Cap. The above illustrations are taken from the work of this expedition, and are typical of the type of work to which small aircraft can be put.

For the second class of work a large multi-engined aeroplane is essential, as at times the safety of the ground party being supplied may depend on the arrival of the aircraft. For this reason absolute reliability and facilities for accurate navigation are of extreme importance. The former can only be obtained by the use of three or more engines, and the latter by having dual control fitted to the aeroplane, and having at least one pilot to each fully qualified as an air navigator. On no account should money be saved by the purchase of second-class navigating instruments. This type of aircraft would be large and cumbersome to move about on the ground, and it would probably need a special run-way to take off from. A crew of six men, including pilots, would be wanted for each plane, but a motor tractor would mean that this crew could handle the plane without calling on other members of the expedition. Wireless would be necessary, and to aid navigation a direction-finding station at the base would be an enormous help. The uses to which such aircraft could be put are obvious. The distances that could be covered by a sledging party could be increased enormously either by laying out food depots at fixed points before the party left, or by supplying them with food at pre-arranged rendezvous. I consider that aircraft used alone is of little or no value, as the best that it can do is to discover whether there is land present or not, and approximately the height of any land found. But if used in a practical way to support sledging parties, huge distances could be covered with a security hitherto unknown. Not only would the distances covered be increased, but the useful work done would be of far more value as more time could be spent over the work, and more instruments carried. Also, as both men and dogs could be much better fed, hardships would not be nearly so much felt.

The ideal equipment for an expedition where money is of no object would include aircraft of both the above types, the small for preliminary reconnaissance flights and short reconnaissance flights throughout, and the large for the longer supporting and depot laying flights. Both types should have enclosed and heated cockpits. Though not absolutely essential, direction-finding wireless would be an immense help. Hangars are absolutely essential, as no work could be carried out in the open in winter, and any blizzards would fill the engines and cockpits with snow. For large aircraft a motor tractor would be required.

APPENDIX II.—CLIMATOLOGICAL NOTES

QUINTIN RILEY

The climate of Greenland in those parts under our observation may be divided into two distinct types: coastal and inland.

The coastal climate is similar to that of most semi-northern countries: never

very cold in winter nor very warm in summer. The highest and lowest recorded temperatures at our coastal station were 63° F. and —3° F. respectively. This minimum has been recorded in Hampshire and zero is not uncommon in Scotland during the winter months. The large amount of sunlight enjoyed during the summer makes the mountain lakes very warm and bathing in July and August is extremely pleasant, though mosquitoes are rather troublesome.

Owing to the structure of Greenland, with its huge ice plateau, the inland climate is polar. In summer, 20 miles from the coast the shade temperature at midday is rarely more than 32°. The highest and lowest recorded temperatures at our inland station, 140 miles from the coast, were 29° in September and —64° in March. But here it must be noted that no observations were taken at this station from May till August, when the maximum summer temperature would probably have been recorded.

It seems convenient to give a brief summary of the climatic conditions of these two distinct types separately.

The Coastal Base Station

We arrived at our base station on the coast at the end of July 1930, and were enjoying the summer weather already referred to. During August mild frosts of one or two degrees were experienced at night, as the sun at this time of year sets for about three hours. The fjord which extended from our base to the sea, some 6 miles away, had floating ice-pans and icebergs which blew in and out from the pack-ice outside. These pans vary in size and thickness and the amount of ice in the fjord varies with the wind. Fine weather continued until the middle of August, when showers of rain were experienced for a few days. On August 31 the first gale was recorded, the wind reaching a speed of some 60 m.p.h. The winds up to this time had been light and generally from a south-easterly direction. This kind of autumn weather persisted until the end of September, when the rain turned into snow and the upper end of the fjord near the inland ice became frozen over with new ice, and at the end of the first week in October most of the fjord north of the base was frozen. On October 8 another gale was experienced. This time the wind reached a speed of 129 m.p.h., when the anemometer blew away, but this figure was certainly exceeded later.

These gales, which we now began to get fairly often, will be treated later, so that in this general summary mention of their occurrence only will be made. The newly frozen ice on the fjord was broken up by the gale. This sequence of frozen water followed by a gale which broke up the fjord persisted till December 8, when the last use was made of the boats till the beginning of June, and the fjord finally froze over.

In November the weather was alternately fine for three days and then snow for three days, with a strong gale (speed over 100 m.p.h.) every four or five days. The temperature was never above freezing, the maximum average being in the nature of 20° F. and the minimum 15°. December was remarkable in that there were no gales at all, otherwise the weather was cloudy with precipitation and fine alternately.

January, February, March, and the first half of April may be summarized together: a large number of fine days with a clear sky, intermingled with overcast days on which precipitation was generally experienced. Gales, which we now looked upon as quite normal, occurred two or three times a week. After April 15 the maximum temperature was always above freezing, the snow began to melt, and no more gales were experienced. This fine spring weather continued till the end of May. At this time of the year a certain amount of coastal fog was recorded, but otherwise little fog was experienced; there was however often a

fog belt seen far out to sea over the pack-ice at other times of the year. Summer may be said to begin on June 1.

On May 28 open water was seen at the mouth of the fjord, and by June 3 the whole of the fjord was open. The speed with which the winter ice on the fjord disappeared was quite remarkable. There was no more frost from now onwards, and the bathing season began again in the middle of the month and continued till the expedition left the base at the beginning of August.

The Ice Cap Station

The inland station, 140 miles from the coast, at an altitude of 8200 feet, had a very much less variable climate than the base. Observations were begun at this station on 8 September 1930. The temperature at this time of year was always below freezing, and the minimum generally of the order of —9° for September. Precipitation was always in the form of snow during the whole time under observation—September to April. The general weather during September varied nearly each day; completely clear blue sky to completely overcast with precipitation. There was little or no wind during this month. A slight wind however makes the visibility bad as the fine powder snow is blown along and rises to a height of about 6 feet. On October 3 the personnel, who had been at the station since the end of August, were relieved and two more people took on the observations till their relief on December 4. During their stay the weather continued in much the same way, although of course the temperature was getting colder all the time and the thermometer rarely went above —20° F.

Visibility at ground-level was on the whole bad at the Ice Cap station owing to the drift-snow already mentioned, but in many cases it could be observed that the drift-snow was a shallow layer, and that the zenith was clear. There would therefore be no inconvenience caused to aircraft unless the pilot wished to land, and in any case it would only mean a drop of probably 10 or 15 feet, which, although damaging an aeroplane, would probably not wreck it.

When the second relief took over on December 4, Courtauld manned the station alone until the abandonment of the place on May 5. Gales were fairly frequent, though the highest wind force recorded was 9 Beaufort Scale. There was no preponderance of northerly gales, as at the base: they were often between east and south. During these five months there was a good deal of precipitation, as might reasonably be expected, but there were also many very fine days.

The Gales at the Base

These have only been mentioned as occurring, but a fuller description seems desirable. These gales always came from the north, and always with the same procedure. First what appeared to be small puffs of smoke were seen coming from the tops of the mountains to the northward of the base, some 5 miles away. This was snow blowing off, and resembled a semi-active volcano. This would gradually increase and a roaring sound would soon be heard. Between this first intimation of a gale arriving and its striking the base there would be a period of about three hours, thus giving plenty of time to fetch in stores and see that everything outside of value was securely fastened.

The next stage of the gale would be a strong wind from the south or south-east; this seems probably a "leeward eddy phenomenon" caused by the formation of the fjord. This south or south-east wind would persist for about fifteen minutes and then the full force of the gale from the north would be felt at one blow. These gales nearly always exceeded a steady 100 m.p.h., and were certainly stronger than the wind in an eastern typhoon, which had been previously

experienced by some of the members of the expedition. It was impossible to stand against these winds, and it was necessary to crawl along and hold on to the rocks during the gusts to prevent being blown backwards.

A gale would generally last about six hours and then retreat in the same manner as its progression. On one occasion the instruments in the screen were being read and the observer was holding on with all his might; suddenly there was complete calm, and before the strong wind from the opposite direction set in the observer was able to walk back to the hut without any wind at all. These gales appear to be extremely local. Angmagssalik, 30 miles away, does not record nearly as many gales nor do they reach the violence there that we experienced. On one occasion a member of the expedition was at an Eskimo settlement 15 miles south of the base and reported a gale on his return for a day on which no gale was experienced at the base; in fact, an aeroplane flight was made. Also these gales do not appear so strong inland; a party returning from the Inland Ice station was some 30 miles from the base when the base was experiencing one of these gales; they reported only a strong wind.

Fuller meteorological results will of course appear in time, as there is a large amount of data as yet not worked out. Hence this account has been kept untechnical and merely aims at giving the kind of weather that may be expected, for information to future travellers.

APPENDIX III.—PRELIMINARY ACCOUNT OF THE GEOLOGICAL WORK

L. R. Wager

The area with which this account deals comprises the Angmagssalik district and the coast to the north as far as Kangerdlugsuak, lat. 68° 10′. A good deal of geological work has been carried out in the fjord region of East Greenland north of Scoresby Sound, but this area, to the south, was known only from the one-day stay at Tasiusak of the Second Dickson Expedition of 1883, led by Nordenskiöld,* and from the work and collections made by H. Knutsen, the mineralogist on Holm's Expedition of 1883–86,† and by C. Kruse, the botanist to Amdrup's Expedition of 1900–1901.‡ From this work it was concluded that the district consisted of Archaean rocks cut by later basic dikes. On Amdrup's boat journey from Scoresby Sound to Angmagssalik§ a change from basalt-mountain scenery to that typical of the metamorphic rocks was seen to occur at Kangerdlugsuak, and existing maps therefore showed the coast from Scoresby Sound to Kangerdlugsuak as basalt and the coast southwards as Archaean.

The recent work is in the main an extension of these general conclusions. The so-called Archaean has been found to consist of varied igneous gneisses with considerable masses of highly metamorphosed sediments and a later phase of plutonic intrusion. The basalts have been found to stretch intermittently for 150 miles farther south than was formerly believed, and a suite of Tertiary plutonic intrusions occurs associated with them. Beneath the basalts on Cape Gustav Holm a thin series of sediments was discovered containing fossils, which, though poorly preserved, are the most southerly yet found in Greenland.

The following preliminary account is based on the field work and on some thirty microscope sections made in Greenland during the winter months. Many

*A. E. Törnebolm, *Geolog. Fören. i. Stockholm*, Förh. viii, 1886.
†H. Knutsen and P. Eberlin, *M.O.G.*, ix, 1889.
‡O. Nordenskiöld, *M.O.G.*, xxviii, 1904.
§G. Amdrup, *M.O.G.*, xxvii, 1912.

interesting points cannot be discussed till further work on the collections has been carried out.

I wish to thank Mr. Watkins, the leader of the expedition, for giving me the opportunity of carrying out geological work in East Greenland, and for the special facilities always afforded to me as geologist. I have also to thank the Council of Reading University for allowing me one year's leave of absence, and the Government Grant Committee of the Royal Society, and the Trustees of the Cambridge University Worts Fund for grants for apparatus used in Greenland.

The Metamorphic Complex

The age of the metamorphic rocks cannot as yet be shown definitely to be Pre-Cambrian, therefore the non-committal name of Metamorphic Complex will be used here. Along the whole stretch of coast which has been visited, the dominant rock of this group is an acid gneiss of igneous origin. Other rocks, somewhat earlier than the bulk of the acid gneiss, have been caught up in it and occur as bands or blocks showing various degrees of viscous flow. The commonest material of this sort is a feebly schistose amphibolite which occurs everywhere to the extent of about 20 per cent. In the Angmagssalik district there is a wide-spread development of basic and ultrabasic rocks characterized by abundant enstatite, and Mount Forel and neighbouring peaks have been found to be made of a somewhat gneissose enstatite granite. These rocks can be proved in many cases to be earlier than the dominant acid gneiss, and they form a well-defined suite somewhat resembling the Charnockite series of Peninsular India.

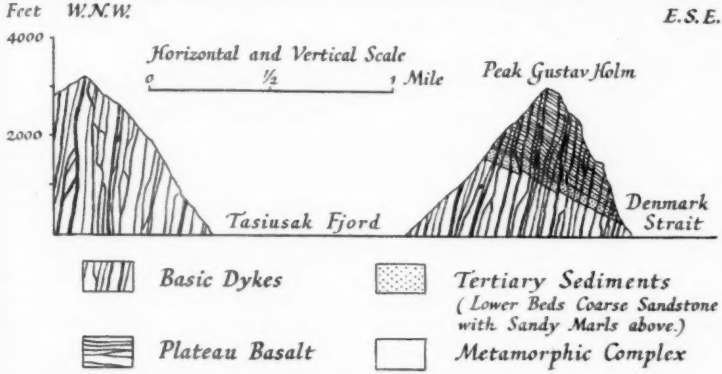
In the southern and central part of the Angmagssalik district and again at Kangerdlugsuak, there are remnants, often several square miles in area, of a sedimentary series of much-altered shales, limestones, and quartzites which are surrounded and injected by the acid gneiss. The pelitic sediments are usually garnet schists, sometimes containing kyanite or sillimanite, and often converted to albite-porphyroblast schists or injection gneisses. About Kangerdlugsuak the gneisses become granulitized. This seems to be an important tectonic line, since there are marked differences between the rocks of the Metamorphic Complex to the north and south—*e.g.* to the south, coarse pegmatites are abundant and the amphibolites are often garnet-bearing; to the north, pegmatites are rare, or, if present, are crushed, while the amphibolites usually do not contain garnets. The rocks of the Metamorphic Complex have a variable, although dominantly W.N.W.–E.S.E., strike. They once formed the roots of folded mountains of the same general trend as the Pre-Cambrian Lewisian Gneiss mountains of the North-West Highlands and the Pre-Cambrian Connemara Schist mountains of Ireland, which stand roughly opposite them on the other side of the North Atlantic.

Early Intrusions into the Metamorphic Complex

Towards the north of the Angmagssalik district about Lake Fjord several cases were found of amphibolite sheets with low dip cutting across the structures of the Metamorphic Complex (Plate 1). They represent sills of dolerite intruded subsequently to the formation of the Metamorphic Complex, but still old enough to have been, at some time, completely altered to amphibolites with feeble foliation parallel to the sheet boundaries. On Angmagssalik Island, on the west side of Sermilik, and in many of the branches of Angmagssalik Fjord, unfoliated pink granite and unfoliated basic plutonic rocks occur. Although perhaps characteristics of composition or structure may later be found in these rocks which will link them to the proved Tertiary intrusions of the district to the north of Angmagssalik, I consider that it is more probable that they will be shown to be Caledonian or Pre-Cambrian in age.

The Tertiary Rocks

As we travelled northwards along the coast from the Angmagssalik district, dolerite dykes with a general N.N.E.–S.S.W. direction, which at first occurred to the extent of one or two per mile, measured across their strike, became more frequent and more varied in type (Plate 1) until, just south of Cape Gustav Holm, dyke material was more abundant than the gneiss into which it is intruded. Even from a distance it could be seen that at Cape Gustav Holm the monotonous Metamorphic Complex and its dykes gave place to different formations. On the northward journey only a very hurried ascent was possible of the 3000-foot peak forming the cape, and on the return journey, owing to the ice conditions, no landing could be made. The district however was worthy of more attention. Resting on the Metamorphic Complex is a thin series of sandstones, limestones, and shales, baked by the numerous dykes cutting through them (see diagram). From the limestones several poorly preserved fossils were collected which Professor H. L. Hawkins has kindly examined. He would compare most of the specimens



Cross-section showing Peak Gustav Holm and mountains to the west, both rising to the general level of the former peneplain, with Tasiusak Fjord cut along the former line of junction between the sediments and the Metamorphic Complex The thickness of the sediments and the individual lava flows are exaggerated

with *Cyrena gravesii*, Deshayes, while one is an undoubted *Glycimeris*. These limestones must be ascribed to the Tertiary and are comparable with Ravn's * "Cyrena bed." Partly intercalated with the sediments, but mainly above them, is a series of thin basalt lava flows. Three miles to the north, where a landing was made on the return journey, intrusions of granite and gabbro were found near the junction of the basalts and the Metamorphic Complex. The sediments and lava flows have a steep dip to the south-east, and the dykes hade to the north-west, but not to such an extent that they remain perpendicular to the bedding of the sediments. The evidence points to all these rocks being of Tertiary age.

From Cape Gustav Holm to Kangerdlugsuak the coast follows roughly the junction between the Metamorphic Complex and the Plateau Basalts with their associated intrusions. Particularly in the neighbourhood of Kialinek, Nualik, and Kangerdlugsuak, extensive plutonic intrusions are developed. At Nualik and Kangerdlugsuak traces of sediments occur, and on both sides of Kangerd-

*J. P. J. Ravn, *M.O.G.*, xxix, pp. 95–140, 1904.

lugsuak, near the mouth, a series of tuffs 100–200 feet thick underlie the basalts. The tuffs are fine-grained and well-bedded, and were laid down in water. So also were the lower basalts which are sometimes spilitic in composition and show pillow structures and autobrecciation. Plutonic intrusions of granite and gabbro were seen to penetrate the basalts or to include fragments of them. The whole suite of plutonic rocks ranging from periodotite and gabbro to granite and other important rock types must be ascribed to the same general period of igneous activity as the Plateau Basalts, *i.e.* they are Tertiary in age.

In this part of East Greenland therefore there is a series of igneous rocks closely comparable with the Tertiary igneous rocks of the Hebrides, Arran, and Antrim. The study of this area has shown that in many cases the phenomena and the sequence of events, described from the Hebrides by English geologists, are repeated here, but there are also new features not yet found among the Tertiary rocks of the North Atlantic Province. Although the facts cannot be given here, the data collected can be interpreted as the result of a regional tensional stress which has caused igneous and tectonic activity and which has led to the effective extension of the North Atlantic.

The Development of the Present Land-Forms

The coastal mountains from Kangerdlugsuak to the Angmagssalik district are of spiky, alpine shape, but when any of them are climbed the surrounding summits can be seen to rise to a general level, showing that they have been cut from a raised peneplain. In the Angmagssalik district this raised peneplain, in the main, slopes gently from the neighbourhood of Mount Forel to the south-south-east, but subsequent work will probably demonstrate certain abrupt changes of level due to faulting. About Kangerdlugsuak the peneplain passes, without modification, from the Metamorphic Complex across the region of Tertiary intrusions on to the Plateau Basalts, thus proving that it is later than the Tertiary igneous activity of the region. In this area the New Mountains, photographed from the air to the northwards, seem to be the result of differential movement of the peneplain, and what evidence we have points to faulting parallel to the coast south of Kangerdlugsuak. This is perhaps a structural line which is a continuation of one established by Dr. Koch* farther north. The present direction of the coast between Kangerdlugsuak and Angmagssalik is controlled by the gentle inclination of the peneplain. The dip of the peneplain seems to be the result of a feeble continuation of the early Tertiary magmatic and tectonic movements.

Just as the main trend of the coast can be related to these big geological phenomena, so, it seems, can the direction of the fjord and valley systems. Neglecting Sermilik Fjord, which I believe has had a more complicated history, there are two sets of valleys and fjords; the dominant set, running south-east or south-south-east, is apparently cut down the steepest slope of the raised peneplain, and is probably only a little modified by the general strike of the Metamorphic Complex; the second set, *e.g.* Angmagssalik Fjord, is parallel to the coast-line and the dyke system, and is probably controlled by faulting parallel to these. It is worth noting that within the area examined the bigger fjords are found where the mountains are higher, and at Kangerdlugsuak and near Kialinek the higher mountains are associated with the greatest development of Tertiary plutonic intrusions.

The shape of individual mountains depends on the Ice Cap and its former extent. About the Base, the lowish mountains have recently been completely overridden by the inland ice, which has modified them into uninteresting rounded

*L. Koch, *M.O.G.*, lxxiii, 1929.

Air-photograph, 10,000 ft. H. G. W.

1. Cape Japetus Steenstrup and coast to the north

2. Mountains south-east of Forel, some showing remains of an early peneplain

2. *Mountains south-east of Forel, some showing remains of an early peneplain*

forms. The climatic conditions at the edge of the ice sheet are such that corrie glaciers have not developed in mountains of this height, so that they are left exactly as they were when the ice sheet retreated. Some of the mountain forms resemble Tinds, and others, called by the natives Sulusuk, meaning a shark's fin, are probably also largely shaped by the ice. To the north and east of Sermilik, where the coastal land is wider and higher, the mountains are alpine in form and have corrie and valley glaciers. They were not, as at the base, recently covered by the extended ice-sheet, and perhaps never have been so covered. However, at the same time as the country round the base was covered by the inland ice, the main valleys and fjords were here occupied by powerful streams of ice descending from the Ice Cap, much as the head of Kangerdlugsuak Fjord is to-day.

The Mount Forel area is particularly interesting in the light that it throws on the development of mountains at the edge of an ice-sheet. Here the ice-sheet seems to cover a surface which is in the main level although, in detail, rolling on much the same scale as Chalk Downs. Some of the mountains seem to begin as small spiky nunataks, others as flat-topped nunataks of considerable area, and the latter give at a somewhat later stage such mountains as Forel and some of its neighbours (Plate 2). This form becomes rapidly rarer towards the coast, and then disappears, mature spiky mountains being produced by the action of frost and the erosion of the surrounding glaciers. In this area there is a higher level and lower level glacier system, and I believe some evidence that glacial erosion has been important in producing the main features of the topography. If in this latitude an area has existed as an elevated tableland for a long period, then it is possible that the ice-sheet covering it may also be of great age. In this case it may well be that ice-erosion has been a main cause in the production of the present topography.

While discussing the development of the Mount Forel country it is worth noting that, from the point of view of geological erosion, the area is a glacier-covered desert. Although water is produced in the sun, during a few days in the summer, on certain rock faces where the winds allow snow to accumulate, most of the rock is never wet, and as a result there is very little chemical decomposition. Certain ferromagnesian minerals of the enstatite granite of the area decompose to a tuft of white carbonates and give the rock a striking speckled appearance. On the level rock surface of the flat-topped nunatak which we visited, the almost continuous winds, carrying traces of sand picked up from the snow-free area, have produced a wind-polished surface.

In the neighbourhood of the Base the Ice Cap margin has recently receded a distance of 5 to 8 miles of fairly mountainous country. Over this area there is practically no moraine material of any form. Similar shrinking of the ice-sheet can be traced in other places, although the evidence is of a different kind. All the glacier tongues from the Ice Cap which have been examined in any detail have moderately extensive moraine deposits at their margin, so that it must be assumed that the Ice Cap has been stationary in its present position for a much longer period than was taken in withdrawing from its extended position. There is a very slight and recent recession noted at all the glacier tongues near the Base of from 20 to 1000 yards, depending on gradient, and the newly exposed land has not yet been colonized by the slow-growing crowberry and juniper.

There is a small area of strandflat off Cape Dan Island, but this was not seen elsewhere. In the fjords north of Angmagssalik Island the present streams, from corrie glaciers, have put down deltas some 100 feet above present sea-level, and of much the same size as those they have now built up at sea-level. The strandflat and the deltas both prove a recent relative rising of the land.

The meteorological data which the expedition has collected have a bearing

on the problem of the maintenance of ice-sheets. Hobbs* and others have stressed the importance of outflowing winds in the removal of snow from the Ice Cap. Although quantitative data are lacking, it is possible to state from our experience of the weather on the Ice Cap throughout a whole year that precipitation is, in general, small. Rough calculations which have been made suggest that, owing to the violent outward drift-bearing winds and the small precipitation, there is now little accumulation of snow on the west side of the Ice Cap in the latitude of Angmagssalik. The movement of the ice, which is small at the edges, must inwards become rapidly negligible, and hence the geological work accomplished, unless over very long periods and near the margin, must be correspondingly slight.

Explanation of Plates

1. Cape Japetus Steenstrup and coast to the north: air photograph showing Tertiary dykes and a sheet of amphibolite. The coast is trending north-east, parallel to the Tertiary dykes. South of Cape Japetus Steenstrup the dykes were all of one type of dolerite; northwards there was considerable variety, and the dykes became rapidly very abundant. A little above sea-level, on Cape Japetus Steenstrup, one of the Early Basic Sheets of Amphibolite can be seen. These sheets cut across the intricate structure of the gneiss of the Metamorphic Complex.

2. A flat-topped mountain south-east of Forel. The mountain rises 6000–7000 feet above the lower glacier system. The flat top is the remains of the original peneplain from which the mountains of the Angmagssalik district, north of Sermilik, have been cut. The photograph is taken looking east and away from the Ice Cap. Westwards and towards the Ice Cap the remains of the peneplain are more abundant. The slope of the rock faces produced by erosion can be seen to be remarkably constant.

APPENDIX IV.—SURVEY

A. Stephenson

The surveys of the expedition can be divided into three branches:

1. A coastal survey from Kangerdlugsuak to Umivik.
2. An inland survey of the coastal mountains.
3. A survey of the general features of the Ice Cap, wherever possible.

1. *The Coastal Survey.*—This was the most important section of the survey. We intended to re-map the coast from Kangerdlugsuak in lat. 68° 02′ N. to Umivik in 65°, using the existing maps of Gustav Holm and G. C. Amdrup as a basis. Owing to the steep and rocky nature of this coast it was difficult to decide on the best method. Finally, we adopted, on the suggestion of Professor Debenham, a small artillery range-finder for measuring the base, and carried on with a plane-table triangulation, using the range-finder wherever triangulation was impossible. Further detail was to be inserted from air photographs.

For an exploratory survey on 1/250,000 this proved very satisfactory. The range-finder was a Barr and Stroud 80 cm. artillery pattern, which gave results within plottable error at distances between 2000 and 3000 yards, and very good approximate results up to 6000 yards. Frequently we made intersections of points previously fixed by the range-finder, and the two agreed.

The coast from Kangerdlugsuak to the base was surveyed in the summer of 1930 by Courtauld, Chapman, and Stephenson. On the way north, while the

*W. H. Hobbs, "The Glacial Anticyclone," New York, 1926.

Quest remained in Lake Fjord and the aeroplane party were taking photographs, the survey party mapped from Kangerdlugsuatsiak to Cape Gustav Holm, travelling in a 16-foot whale-boat with an outboard engine. On this journey we were working to our own time, the ice conditions were favourable, and the coast was well indented with bays which facilitated fixing detail. The fjords were also straightforward to map, since only one measurement was made across the head and then a triangulation was carried down the length of the fjord. Occasional islands off the coast facilitated triangulation and decreased dependence upon the range-finder. We consider our map of the first strip of coast accurate to 500 yards. In the Kangerdlugsuak section conditions were similar, and a like order of accuracy can be expected.

Working south from Kangerdlugsuak conditions were different. We were travelling with the *Quest* and speed was essential. For the first 50 miles, as far south as Aggas Island, the ice conditions were bad, and even when the coast was accessible it was unsuitable for landing. Hence we had to work from islands off the coast, using the range-finder to determine longer distances than usual. This meant that our scale was unreliable, but the detail relatively accurate. The map has been adjusted to the astronomical positions. Amdrup had made frequent observations, and his latitudes agreed very well with ours. The longitudes however did not agree. All our longitudes proved to be farther west than those of Amdrup, on the coast journey, at Angmagssalik, and at the base. All our longitudes depend on W/T signals.

South of Aggas Island the many islands assist triangulation. We were driven in behind Kialinek Island by bad weather, so we mapped the hitherto uncharted mainland and neglected the seaward side of the islands mapped by Amdrup.

From Poulsen's Fjord to Cape Gustav Holm we had to leave a gap, since we were forced to travel after dusk to seek shelter from more bad weather. The coast here however is very plain, and aeroplane photographs show it to agree very well with Amdrup's map. The final map of the coast from Kangerdlugsuak to Cape Gustav Holm, after being adjusted to the astronomically determined positions, should have an accuracy within 1000 yards.

South of Kangerdlugsuatsiak we were hindered rather than helped by the islands. We concentrated on the mainland as far as possible, fixing only prominent points on the islands with detail from the air photographs.

From Leif's Island, south to Cape Dan, we were content with mapping the seaward islands only, as with our limited time and personnel we could not improve on the map made by the native schoolmaster, based on Gustav Holm's original with greatly improved detail.

The coast south of the base to Umivik was mapped in the summer of 1931 by Lemon and Courtauld when travelling south with Watkins to Julianehaab.

Captain Lemon's account says that the preliminary aeroplane reconnaissance had shown that the coast between the base and Pikiutdlek was fairly well surveyed by Gustav Holm's 1884–85 Expedition. Lemon used the same methods as the northern party and the same scale (1/250,000). The first section mapped was from the south side of Kivdlak to Ikermiut, the terminal bases being Kajartalik and Pikiutdliuta. This section was the most satisfactory, and the accuracy should be within 500 yards, except in Pikiutdlip–Ikera and outside the islands of Tasitsek.

The second section between Ikermiut and Kulusuk was the least satisfactory. Triangulation was possible as far as Kangek, but between Kangek and Kulusuk a patent-log traverse and an azimuth only was possible. The inaccuracy in this section may be as much as 2000 yards in places.

The third section, Umivik Bay, was mapped separately on fresh bases and was

joined up to the second section by a range-finder and azimuth traverse in the channel between Kulusuk and the mainland. The accuracy of this section should be of the order of 1000 yards.

Oblique aeroplane photographs were taken by Watkins of the whole coast from Kangerdlugsuak to Umivik from a height of 10,000 feet. No mechanical charge was used in taking these plates, so the field of view is not constant, nor the angle at which they were taken. Along the coast there are sufficient fixed points to fill in detail from the photographs with very little loss of accuracy. Inland, detail can only be interpolated approximately. Nevertheless, the complete set of photos gives a very good idea of the extent inland which the mountains reach, and of their approximate area.

During the autumn a survey of the base fjord was done on the scale of 1/63,360. For this a base of 1000 yards was measured by sub-tense methods, and heights were determined with an Indian clinometer. The range-finder was little used in this survey, detail being fixed by plane-table.

2. *The Inland Survey.*—The chief survey inland was of the region around Mount Forel, an area quite unknown apart from a few peaks fixed from a distance of 70 to 100 miles by De Quervain in 1912. Unfortunately we had no plane-table with us and we had to make rounds of angles with the theodolite from as many mountains and nunataks as we could. From sketch-maps made at the same time and our photographs we were able to fill in the detail, within the rough theodolite triangulation. The base was measured along a straight ski track, by a sledge-meter, reading to one-tenth of a mile, the mean of a number of runs being taken.

The map was drawn on a scale of 1/63,360, with heights by theodolite, based on datum by the aneroid and hypsometer, reduced by Mr. Mirrlees of the Meteorological Office.

Both on the Forel journey and the journey towards Forel in March and April an attempt was made to map the inland border of the coastal mountains. This was done by taking rounds of angles to the prominent peaks from points 15 to 30 miles apart. Unfortunately the number of peaks that can be distinguished for certain, from two points so far apart, were very limited, and what points we did fix coincided with those fixed by De Quervain. The actual edge of the mountains could not be fixed without travelling well within the crevassed area, which made the speed of travelling too slow and the course too devious. However we obtained a very good idea of the positions of the outlet glaciers, and from the tops of the mountains around Forel we were able to connect these up with the glacier systems within the mountains, thus adding considerably to the detail of De Quervain's map. Judging from our experiences, both on the west and east coasts, the delineation of the inland border of the coastal mountains is very inaccurate in most parts of Greenland.

3. *The Ice Cap Survey.*—On all the Ice Cap journeys meteorological observations were taken three times a day. The pressure was usually read from a Negretti and Zambra or a Palilin aneroid, which registered up to 15,000 feet and 10,000 feet above sea-level respectively. These observations have all been corrected and adjusted at the Meteorological Office, and when in combination with the results of Nansen and De Quervain they supply sufficient detail for an approximation to the shape of the Ice Cap in Southern Greenland.

North of the Ice Cap station the inland ice rises to a maximum height of nearly 10,000 feet in the region of the German centre station. At the Ice Cap station itself and for a distance of 100 miles south of that latitude the height is in the region of 8000 feet. Farther south it rises again, and the maximum height reached on the crossing to Ivigtut was 9200 feet. At first sight it appears then that there is a trough running across Greenland in the latitude of 65° to 67°, as assumed by

De Quervain and by Lauge Koch. This assumption was based on the theory that the maximum height of the Ice Cap was slightly to the east of the centre of the continent, and that the north–south line joining the maximum heights of the various crossings represented the highest part in any particular latitude. This theory does not fit in with the results obtained by Rymill and Hampton on their crossing from the base to Holsteinsborg. On this journey they passed the region of the Ice Cap station at a height of 8000 feet, and then continued to rise, and did not reach their maximum height of about 9000 feet until about 60 miles west of the supposed summit. From this it appears that the line of maximum height comes south from latitude 71° to 67° slightly east of the middle of the continent, then it swings in to the west for 60 miles in the latitude of 65° to 67°, and finally continues to the south, slightly east of the central line. The latter factor agrees with the position of the maximum height reached on the Ivigtut crossing.

The surface of the ice itself consists of a series of continuously rising broad undulations up to 3 or 4 miles across and 300 or 400 feet deep. It is very difficult to determine the direction of these valleys, as they invariably appear to be crescentric and seem to have no connection with the direction of movement of the ice. For a distance of about 60 miles in the centre these undulations are much less noticeable and the surface is almost flat with little rise or fall. On the east coast the fall of the ice is steeper than on the west coast, with the result that the crevasses are restricted to a much narrower belt on the east. Except at the head of big valleys such as Sermilik Fjord, the crevasses do not extend more than 15 miles from the edge of the Ice Cap; whereas on the west coast they are encountered 70 to 100 miles inland. The difference in slope also accounts for the large difference in the amount of surface water in summer. On the east coast these streams occur, but they are restricted to narrow channels, occasionally collecting into lakes a mile or two in diameter. On the west coast however Rymill and Hampton encountered rivers of thaw water, 40 to 50 feet wide and 4 or 5 feet deep, at a distance of 25 miles from the mountains. Similar conditions were forecasted by Scott's party when they reached the Ivigtut district in July, for even then, a month before the wettest period, there were wider streams and larger lakes to be crossed than on the east coast in August.

APPENDIX V.—SLEDGING RATIONS

H. G. Watkins

Sledging rations of the B.A.A.R.E. were very different from any previous Arctic or Antarctic rations. I based these rations originally upon those used by Scott and Shackleton in the Antarctic, modified by up-to-date knowledge of dietetics and also by practical experience gained in Edge Island and Labrador. The original rations (one man for one day) used in Edge Island were as follows:

Bovril Pemmican	8 ozs.
Plasmon Wholemeal Ship's Biscuits	16
Cadbury's Milk Chocolate	4
Tate and Lyle Cube Sugar	4
Total	32

This ration was found to be adequate for a short summer Arctic journey. It would be useless for a prolonged journey in cold weather, since it is entirely lacking in Vitamin C and in several other essentials, and its calorific value would not be high enough for hard work in low temperatures.

Rations used in Labrador were as follows:

Bovril Pemmican	8 ozs.
Plasmon Wholemeal Ship's Biscuits	12
Cadbury's Milk Chocolate	2
Tate and Lyle Cube Sugar	4
Maypole Margarine	3
Plasmon Oats	3
Plasmon Powder	1
Total	33

Also a very small quantity of Marmite.

These rations were found to be excellent. I had reduced the amount of biscuit, and added margarine. This immediately raised the total calorific value of the rations, since fat has about double the calorific value of carbohydrate. Vitamin C was supplied by fir tea made by boiling the shoots off fir trees in water. Vitamin B was supplied by the Marmite.

These rations were still of rather low calorific value for really hard working in a low temperature. This was remedied in the rations for the B.A.A.R.E., which were as follows:

Bovril Pemmican	8 ozs.
Maypole Margarine	8
Plasmon Wholemeal Ship's Biscuits	4
W. and D. Harvest's Prepared Peaflour	2
Plasmon Powder	2
Plasmon Oats	3
Tate and Lyle Cube Sugar	4
Cadbury's Cocoa and Milk Powder	1
Cadbury's Milk Chocolate	3
Horlick's Malted Milk	0·5
Total	35·5

Also small quantities of—

Cod Liver Oil.
Dry Yeast Powder.
Lemon Juice.
Essential Salts.

The total value of this ration was about 6000 calories, and it contained correct proportions of carbohydrate, fat, and protein. Vitamins A and D were supplied by the cod liver oil; Vitamin B by the dried yeast powder, manufactured by Pharmaco Chemical Products, Ltd.; Vitamin C was supplied by the concentrated lemon juice, specially prepared by Messrs. Lyons. This ration differed essentially from all others in the small quantity of biscuit and the large quantity of margarine (8 ozs.). Reducing the carbohydrate and increasing the fat was the only way to increase the total calorific value of the rations without increasing their weight. There was no difficulty at all in assimilating this extra quantity of fat. In fact, in very cold weather, working hard, we frequently felt we would welcome more margarine.

We soon found that these rations were more than enough for men travelling between 20 and 30 miles a day at low temperatures at a height of about 8000 feet, and towards the end of our time in Greenland we reduced the rations by about one-third, so that the total amount eaten by one man in a day was 23·6 ozs. This was found ample for all normal winter sledging work. On all future expedi-

tions I would keep the rations per man per day under 1½ lb. I would cut out biscuit altogether, but would slightly increase the chocolate or sugar rations.

On several occasions sledging parties lived for two months on these rations, and all the men used to feel extremely fit at the end of every journey. Courtauld, at the Ice Cap station, lived for five months on these rations on a reduced scale, and was perfectly fit at the end of it, showing no signs indicating lack of anything essential.

On coast journeys where seal meat can be obtained it is unnecessary and foolish to take any ration whatsoever, since seal meat and blubber supply everything that is necessary to life. And after a week or so of living on seal meat most of us lost all desire for civilized foods.

The sledging rations for the dogs consisted of a pound of Bovril dog pemmican and a quarter of a pound of Maypole dog fat per dog per day. On the longest journeys in cold weather the dogs kept perfectly fit on these rations. On summer journeys the extra fat is not necessary.

I am deeply indebted to Dr. Zilva, of the Lister Institute of Preventive Medicine, who assisted me enormously in the preparation and calculation of the rations of this expedition.

APPENDIX VI.—SOME FIELD-NOTES ON THE BIRDS OF EAST GREENLAND

F. Spencer Chapman

In these pages there is room for little more than an outline in note form of more than a year's work on ground much of which was previously unvisited by Europeans, much less by ornithologists. I give here little more than a list of the species seen at different times, and have avoided the controversial ground of subspecies, which together with other more detailed work will be dealt with in a more comprehensive paper appearing in the *Ibis*.

The ornithology will be dealt with under the following headings: District around the base and Angmagssalik settlement; Coast journey from the base to Kangerdlugsuak; Movement on the Ice Cap.

District around the Base and Angmagssalik Settlement

The base was established in lat. 65° 38′ N., long. 38° 38′ W. on 27 July 1930; from then till August 11, when the journeys started, there was little time for ornithological work. I was away from the base most of the time from August till the end of the year, and again in March and April 1931. As there was no one who could continue the observations there are unfortunately some large gaps. However I have included a few notes by other members of the expedition, who were always willing to co-operate, and by Eskimos when I have been quite certain of authenticity.

The base was on a low promontory at the head of a fjord about 5 miles long, which ran approximately north and south. At the beginning of August, in the fjord, hundreds of Arctic Terns were nesting on the low islands, though the Eskimos invariably took the eggs. There were many Glaucous and Iceland Gulls, the Glaucous being far more common; in both species about one-third of the number were immature birds. At the mouth of the fjord Black Guillemots and occasional Eiders were seen, while the Long-tailed Duck—of which there were about twenty birds—kept to the head of the fjord. Greenland Mallard, Red-breasted Merganser, and Red-throated Diver, with a single pair of Great Northern Diver, flew between the fjord and the lakes where they bred.

On the foreshore the Ringed Plover far outnumbered the Greenland Dunlin and Purple Sandpiper, with which it associated—very immature birds of these three species indicated that they bred here.

Snow-Buntings, Lapland Buntings, and Greenland Wheatears were all nesting near the base in the rough proportion of 9 : 1 : 4 respectively. Snow-Buntings nested up to 1000 feet, Wheatears to about two-thirds of that height, while the Lapland Buntings were confined to the marshy hummocky areas usually near the lakes. Ravens, usually three of them together, and a very white Greenland Falcon, frequently came down from the higher ground to feed near the base. Ptarmigan were rarely seen: there seemed to be only three pairs with broods in the base fjord.

Lemon noticed that toward the end of August the Gulls increased considerably in the fjord. On August 20 he found the fresh remains of a male Merlin. At the beginning of September natives brought in several Brent Geese, small parties of which appeared in the fjord till September 12. On September 18 I saw an unmistakable White-fronted Goose settle on the base fjord.

The Divers, Mergansers, and Mallard left the lakes about September 20, but I saw Long-tailed Duck as late as October 24. Most of the Gulls left during the third week of October, leaving a majority of immature birds. The last Snow-Bunting was seen flying over the base on October 15, though Wheatears were still present on October 23. In August I had heard and seen occasional Greenland Redpolls foraging round the base, though I could find no nesting-place within 2 miles; on October 28 I was surprised to see a Redpoll—I think of this species—flying south over the moraines at the Ice Cap foot.

I was continuously at or near the base from December 19 to March 12, though naturally there were then few birds to observe. Ravens wintered with us, feeding largely on the berries of *Empetrum nigrum*, which were often uncovered by the winter gales. This too supported the Ptarmigan, which was present, though in small numbers, through the winter. Occasional Falcons of both light and dark forms were seen in every month except November. Gulls, usually immature birds, visited the fjords occasionally, no more than five being seen together, and then after a gale: they were nearly always Glaucous Gulls.

On December 29 several of us visited an Eskimo winter-house 15 miles south-west of the base, and stayed there for some time. Here there was more open water around a group of low islands, and I saw as many as thirty Black Guillemots together. After violent southerly gales at the beginning of January small parties of Brunnick's Guillemot joined them. This gale also brought in several Ivory Gulls, five being seen together on January 3; two out of three of these Gulls were immature. Eiders were fairly frequent in the open water.

At the end of February the courtship of the Ravens started, and on March 11 the first Snow-Bunting reached the base. Scott noticed that Ptarmigan increased very much after March 10: they seemed to come in a few days after the gales.

It was not till April 10 that any number of Snow-Buntings arrived, and on this date I saw the first female bird. On April 15 an Eskimo saw a Snowy Owl in the fjord to the south. Up till April 21, when I went to the Ice Cap again, no other migrants had arrived: the Gulls and Black Guillemots in the fjord had, if anything, decreased. When I returned on May 11 the following had been recorded:

April 30. Purple Sandpipers at the head of the fjord.
May 4. Several flights of "ducks or geese" up the fjord.
5. A large skein of Geese going north up the fjord. An Eskimo brought in a Long-tailed Duck and a White-fronted Goose, which he had shot two days previously.

May 7. Scott saw a Wheatear and noticed that after the date Ptarmigan became wilder and scarcer.

10. D'Aeth identified a White Wagtail near the base.

From May 11 till August 9, when the majority of the expedition left Greenland, a large amount of data was collected, of which the following is a very brief summary:

May 11. Three Golden Plover seen at base: they only remained a few days.

14. Parties of Brent Geese passed over the base fjord: eleven settled on the sea-ice, but were very wild.

16. Ringed Plovers appeared, also Lapland Buntings. Two White Wagtails seen; though a nest with six eggs was found at Angmagssalik on June 16 we saw none at the base after May 17.

17. Several skeins of Geese and a flock of Eiders flying up Sermilik Fjord. By now pools had thawed in the sea-ice and the margins of the lakes had melted. The snow had vanished from the southern slopes.

18. Arctic Terns seen at the fjord mouth.

21. A Snipe settled near the base. A second was shot May 20 at Angmagssalik.

24. Meadow Pipit near the base: after this none reappeared till May 28, when a pair started nesting. It is significant that the Golden Plover, Snipe, White Wagtail, and Meadow Pipit, all of which nest only a few hundred miles east, in Iceland, all appeared for a few days and then vanished, as if they had overshot their destination. However in some cases—apparently not every year—they remain and breed.

26. Three Red-throated Divers settled on a pool in the sea-ice, a few hours later a pair of Long-Tailed Ducks joined them; on the following day three Red-breasted Mergansers found this pool. The birds seem to find the pools the very day they are formed.

27. Three Dunlin joined the Ringed Plover on the foreshore.

31. A skein of 1000–1500 Geese flew silently north-west up the fjord. I am almost certain they were Pink-footed Geese.

June 1. A Turnstone feeding with Ringed Plover.

2. Two Redpolls passed over the base. First Great Northern Divers seen: a pair, on a large lake.

3. The fjords really opening up now. Mosquitoes first became troublesome. A native brought eggs of Glaucous Gull and said that he had first seen Gulls' eggs a week ago.

8. A Turnstone and two Sanderling at the mouth of Sermilik Fjord.

For the rest of June I was at Angmagssalik settlement and made a census of the birds present. The result was amazing in that the majority of the birds, of which there were in any case extraordinarily few, appeared not to be attempting to nest and seemed frequently to congregate in groups of three.

Other notes from the neighbourhood are as follows:

July 13. A pair of Red-necked Phalaropes with four chicks on a marsh south of the base. Here I saw a Wigeon with two Mallard. Several times later I saw the three together.

22. I saw a Knot with two Turnstone on a rock at the mouth of Sermilik Fjord.

24. A native brought in the remains of a drake King-Eider which he had shot from a party of five at the fjord mouth.

25. A native brought in a drake Greenland Eider.

Aug. 1. An immature Arctic Skua was shot in the base fjord.

Coast Journey from the Base to Kangerdlugsuak

The coast-line north of the base is, with the exception of a few fjords, extremely barren; very few species were therefore observed and the number of individual birds was correspondingly small. In the pack-ice Fulmar Petrels were scarce, though in the second week of October the fjords were full of them—they were almost all of the pale form.

Kittiwakes seemed most abundant just north of Angmagssalik settlement; but I found no sign of nesting in this area. A few small parties of Eiders were seen as far north as Kangerdlugsuak.

On August 16 I saw four Barnacle-Geese on a large lake at the head of a fjord in lat. 66° 20′. At the head of Kangerdlugsuak there were several Sanderling and a pair of Turnstone. Glaucous and Iceland Gulls nested as far north as Kangerdlugsuak, getting scarcer farther north. Snow-Buntings, Greenland Wheatears, Black Guillemots, and Ptarmigan all nested sparingly over this whole stretch of coast. I saw no Lapland Bunting nesting north of Sermilik Fjord.

Movement on the Ice Cap

As there seem to be no notes about birds met with on the Greenland Ice Cap, other than an occasional mention of Snow-Buntings by Nansen, I have included, however briefly, the birds seen on various journeys from the base to the Ice Cap station. Lack of space prevents me from including all Ice Cap journeys. It seems that in spite of the extraordinary number of birds encountered there are at present insufficient data to decide whether birds willingly and regularly migrate across the Ice Cap, or if the following notes are of mere casual wanderers.

The Ice Cap station was in lat. 67° 03′ N., long. 41° 49′ W., and about 120 miles north-west of the base. It was approximately 8600 feet above sea-level.

1930

Aug. 21. Four "dark Snipe-sized birds" circled low over the sledges with an incessant sharp note, and went off eastward. This was 85 miles in.

23. Twenty miles farther in a "thick-set Puffin-like black and white bird" settled in the snow near the sledges.

Sept. 23. Twenty miles in I heard a Snow-Bunting but could not see it.

26. Thirty miles farther in a Snow-Bunting flew aimlessly westward. Later on I saw five Waders going west. I had a good view, and think they were Grey Phalaropes.

28. Two thick-set "Ducks or Guillemots" seen 75 miles in; these flew off eastward. Though I was only a few miles to the east of the party that saw them on this day, they did not pass me. Later on I saw a Red-necked Phalarope approaching from the east, calling often.

Oct. 1. One hundred and ten miles in a Snow-Bunting flying west.

2. Four miles farther in a Snow-Bunting heard.

4. A single Gull (species uncertain) appeared from the south-east and flew off north-west.

1931

April 6. Scott found a dead male Snow-Bunting 120 miles in. He could be certain from the snow conditions that it had not been there more than a day.

23. Twenty miles in a Snow-Bunting circled round us and went off east of south.

May 3. One hundred and ten miles in a Snow-Bunting flying east.

8. Sixty miles in a Snow-Bunting flew over us and went off north-west.

10. Several Snow-Buntings 15 miles in.

DISCUSSION

Before the paper the PRESIDENT (Admiral Sir WILLIAM GOODENOUGH) said: H.R.H. The Prince of Wales has sent the following telegram: "On the return of the British Arctic Air Route Expedition the Prince of Wales, as Honorary President, sends his sincere congratulations to its members on the work which they have accomplished." I have sent a reply to H.R.H. thanking him for his message.

Greenland was the scene of some activity last year and in the first six or eight months of this year. I speak geographically, Your Excellency, and of those sciences which are kindred to that which we profess in this building. In the north was the Wegener Expedition, and there, much to the loss of science generally and most unhappily, Dr. Alfred Wegener lost his life; Dr. Lauge Koch, whom we welcome here to-night with great sincerity, pre-eminent in all that has to do with Greenland travel; Knud Rasmussen, to whom Greenland is almost a land of adoption; and there were others. And on the east coast, some 30 miles south of Angmagssalik, a place you will soon be shown on the map, there was an expedition of our own countrymen, young in years but bold in purpose, led by one no older than the rest, younger than most, whom not for the first nor the second, but for the third time we welcome here to-night to give us an account of an expedition of which he was the leader.

In 1927, not then twenty-one years of age and an undergraduate at Cambridge, he led an expedition to Edge Island: that showed his aspirations. In the winter of 1928–29 he led an expedition to Labrador, and did some valuable survey work under very arduous conditions; that showed his quality. Now he has led a very much more important expedition, the primary object of which was to investigate the possibility of an air-route from this country to Canada by Iceland, Greenland, Baffin Land through Fort Churchill and on, and he returns to us from that expedition a master of his profession.

It is not to be supposed that in an hour Mr. Watkins is going to tell us all that happened on an expedition which has lasted fifteen months and more; but what he can he will tell us in the lecture to which, I can assure you, Mr. Watkins, we shall pay the greatest attention.

Mr. Watkins then read the paper printed above, and a discussion followed.

The PRESIDENT: I am sure that we should be glad to hear a great deal more from all the members of the expedition who went on the various journeys. That, unfortunately, is not possible to-night. We have arranged for a second lecture to be delivered later in the session, at which a description will be given by other members of the expedition. There is however one who undertook and underwent a somewhat unique and unusual experience from whom I am sure you would like to hear a word or two. Mr. Augustine Courtauld.

Mr. AUGUSTINE COURTAULD: You have heard far too much about my little part in the expedition, so I am not going to say anything further about that. There are however one or two remarks I should like to make, if I can have a minute or two. The lecturer has mentioned that we are very much indebted to the Danish Government. We certainly are. Nobody could have been more hospitable. I do not think people in England ever can realize what hospitality means until they see how other people do you, particularly how the Danish do you. We—and I am speaking on behalf of all the members of the expedition—are sometimes ashamed to ask foreigners to England because we feel we cannot entertain them in the jolly way they entertained us in Greenland.

But what I want to stress more than that is the way the Danes run Greenland for the people of Greenland. Greenland belongs to the Eskimos by right; in

fact, they have been there since before history began. Not only do the Danes run Greenland for the Eskimos, but they study them in all their scientific aspects and send out the best men they can find to study the Eskimos. They are one of the most interesting people, and any one who wants to know more about them has only to study the Danish publication 'Meddelelse om Grönland' in order to learn almost everything that can be known about the Eskimos; and if you wish to study further about them, read Dr. Rasmussen's books. I think there is very little which has been written or known about them that you will not find there. I have seen one or two peoples administered in different parts of the world by white races, but I have never seen a race administered so disinterestedly and so unselfishly for their own good as are the Eskimos in Greenland.

It is fitting that a word should now be said by one of the members of the expedition about the man who did all the work. I do not feel that I am the one to speak, but I would like to impress on you what you know already, that to be an Arctic explorer now means no more really than to be a tube-train traveller. We, who went with Watkins, were fortunate in not being tied, that we could just go and do what we were told. It is, of course, an advantage to be fairly young and fit. If you are not fit it is rather more unpleasant if you have to take exercise than when you are fit. Even that is not essential. A couple of months in Greenland will make even the sorriest individual fit. To be a leader of an Arctic expedition is quite another matter. I would not care for it if I had the opportunity. It is a job that needs a tremendous amount of tact, as you may know. I am not going to enlarge on that. But you gave your confidence to Mr. Watkins in fitting out this expedition and putting your name to it; and, if in the future the country is in a state when another expedition can go out, I know that you will back him with the confidence which he deserves.

The PRESIDENT: Dr. Lauge Koch requires no introduction to this Society, especially when he speaks about Greenland.

Dr. LAUGE KOCH: As a representative of the Greenland Government it is indeed a great pleasure to be present to-night. It will also be a pleasure to me to go home and report what the members of the expedition have said about what we are trying to do in Greenland and trying to do for the Eskimos. We have been very glad to see the Watkins Expedition in Greenland; it has been an honour for us to have that expedition there, to do very good scientific work and good exploration. It seems to me that we are to-night dealing with one of the really great expeditions, and its results are so comprehensive that they call to mind a number of other great English Greenland expeditions, such as Ross's and Inglefield's to West Greenland, Beaumont's to the north coast, Scoresby's, Clavering's, and Sabine's to the east coast.

May I add, sir, a few words to the congratulations already offered to Mr. Watkins, though after you have heard his lecture it hardly seems necessary. Take care of Mr. Watkins and his companions. I beg you not to misunderstand my words. Perhaps you do not think, after hearing to-night about the experiences of the expedition, for instance on the inland ice, there is any reason to take care of them. But still I wish to say this: Years are passing rapidly, and it is only during a short period of one's life that one is able to carry on the work they have carried on. Employ them while they are young in spite of economic questions and other difficulties. Time is short. Let them do what they can do now. By this expedition England has once more inscribed its name in the history of Polar exploration and maintained its grand traditions. I congratulate England and this Society, as well as Watkins and his party, on the successful expedition and its great results.

The PRESIDENT: Mr. Wordie is one of those who has been in Greenland and has great knowledge of Polar exploration in many different phases.

Mr. J. M. WORDIE: Dr. Koch has expressed more ably than I can the extraordinary pleasure and, more than that, the enthusiasm which everybody must have felt to-night in listening to Mr. Watkins's description of his great journeys. I feel sure that his expedition would have won the approval of the great Antarctic explorers, Shackleton and Scott, as of all who can appreciate the hardships which the parties endured, particularly on Mr. Chapman's journey in November and December in the winter months, and also during that wonderful boat journey which Mr. Watkins himself led round the south coast. I do not think any other expedition which has gone from this country has ever had such variety of experience. The number of journeys which I counted was at least seven, almost every one of them different in some feature and all of them demanding skill in leadership and powers of great physical endurance in order to carry them through. May I express to Mr. Watkins, on behalf of others who have travelled both in the north and in the south, the enthusiasm which we feel for him to-night and the wish, which must be common to all of us and which Dr. Koch has already voiced, that we may see Mr. Watkins setting out again on another expedition as soon as possible.

The PRESIDENT: A great British authority on Polar exploration and its history, and all to do with it, is Dr. Mill.

Dr. H. R. MILL: I feel ashamed indeed, after these experienced explorers have spoken, to appear before you as an "authority," for I have the one claim that I have been acquainted with Polar explorers who have taken part in every expedition since the year 1838. I was not born in '38, but fifty years later I knew men, notably Sir Joseph Hooker, who sailed with Sir James Ross in the *Erebus*, and heroes of the Franklin Search who sat on the front benches of this Society and took part in the welcome given to Polar explorers like Nares and Gresley, Nansen, Scott, and Shackleton.

It is curious how history repeats itself: a thousand years ago the Scandinavians, feeling out for the first time a sea-route from Europe to America, made their way by the stages of Iceland and Greenland to Wineland, and now, in the days so many people sneer at as unheroic, these splendid young fellows who have been taking part with Mr. Watkins in his expedition are laying the foundations of new air-routes by the same old way through Iceland and Greenland to Canada. The problems of Greenland have engaged Polar explorers in all times, and it is strange now to look back on the efforts of the old veterans, like Nordenskiöld and Whymper, who endeavoured to scale the edges of the Ice Cap. Not until that grand young Scandinavian, Nansen, threw overboard the bugbear of all old explorers, the line of retreat, and forced his way ever forward from the unknown to the inhabited side was it shown how the Ice Cap could be crossed with no appalling hardships. We have seen to-night how in later years the example of Nansen has borne fruit. One after another of his countrymen and kinsmen of the Scandinavian countries, and especially the Danes, have made of that Ice Cap a line of travel which American explorers, like Peary, helped to make familiar.

And now we have our own British expedition which has done magnificent scientific work in an endeavour to elucidate the central problem of air travel to America by this route, the meteorology of the Ice Cap. This is not an occasion to go into what they have done so far as scientific results are concerned, but it certainly is an occasion when we may congratulate ourselves, as we congratulate them, on the proof they have given of the power of youth to overcome all difficulties. In old days the one theme of all Polar explorers was a tale of hardships: the sufferings they endured, the way in which they bore them, and the small results they brought home. Now we find these young fellows coming back happy and healthy as if they were returning from a winter sports holiday. They

have brought with them a mass of important results which their modesty has not permitted them to refer to but which will fill many volumes before the century is much older. I sincerely re-echo the words of Dr. Lauge Koch, that we ought not to allow these young men to rust and waste away after all they have done. They have proved their capabilities, and there is no part of the world where so much work remains to be done as in the Polar regions. Next year we are repeating the experiment of fifty years ago when a series of Arctic and Antarctic expeditions were sent out by many nations to study scientific problems of the Polar regions, and here we have a whole body of trained men eager and anxious and able to go back to the far north or out to the far south.

All that is lacking is money enough to equip an expedition, the search for which in the past has proved so miserable a hindrance and so formidable a difficulty to explorers. Must this state of things continue?

The PRESIDENT: Mr. Watkins, you have placed yourself in the front rank of Polar explorers and travellers. I will ask all the members of the expedition to come on the platform with me. You have been well supported, and with the support of such a band as this success was assured. They will be the first to agree that the leader of such an expedition stands in quite a different position to any other member. It is for him to say "Yes" and for him to say "No." You, Mr. Watkins, have shown your ability to assume serious responsibility without fear of consequence, and you have secured the confidence, loyalty, and affection of your companions. Therefore, Mr. Watkins, with no unhesitating voice we give you our most cordial admiration for the great expedition of which you have been the leader. I think of how great men such as Nansen, Scott, Shackleton, and many others, would have enjoyed being here to-night to listen to your experiences and adventures and to have discussed with you and your companions on terms of equality all the various problems which you found before you and which you have assisted to solve in that still hardly understood but most enthralling occupation and preoccupation of Polar expeditionary research and travel. I say hardly understood because I am often asked, and I am sure many of you are too, what it is for, what it is all about. Well, you have had a very fair answer to-night. But I refer those who ask me that question to Nansen's writings. Read what he said when he was asked that question: What were they doing in the ice and snow? and he quoted the King's Mirror. Read, too, that very beautiful piece of English prose which he wrote describing the Arctic Night. Read again of the impressions made on the most sensitive mind of Robert Scott, that drew from him some wonderful expressions on his last journey of the immensity of his surroundings. Though they cannot be here there are others who can appreciate what you have done. You have heard Dr. Lauge Koch speak. I have a message from Knud Rasmussen saying how sorry he is that he cannot come over from Copenhagen and be with us; and a telegram from Stefansson, whose Christian name I will not attempt to pronounce any more than my predecessor did. I once asked him how he pronounced it, and he told me it was a trade secret. He says: "At your meeting I hope that the President will include me among those who desire to express to Watkins and his colleagues my admiration for the fine work they have done in Greenland, and to the Society congratulations on the support they have given this important expedition."

It was not to be supposed, as I said at the beginning, that Mr. Watkins in an hour could tell us a tenth or one-hundredth part of the work which has been done. I am not going to attempt to comment on it to-night. What I would attempt to do is to express to you our admiration. You have made light of your difficulties, and that is as it should be. But we know well the hardships involved in such work and the grave anxieties that must from time to time have assailed

you. I would like to take the opportunity of thanking the three Government Departments who were able to assist. We welcome here, and I think it is the first time he has been with us, the First Lord of the Admiralty; we welcome him with very great satisfaction. Of the companions who were with you, Mr. Watkins, Captain Lemon, I am sorry to hear, is not well, but I am glad to know that it is not a very serious business. Mr. Lindsay has gone back to his regiment in China and is no doubt assisting to dam the floods which are very different to what he found in Greenland. And Dr. Bingham, having been perhaps not very warm in Greenland, is sunning himself on the West Coast of Africa. The remainder we welcome here to-night.

When you went on your first and on your second, and even on your third expedition, Mr. Watkins, we ventured in this Society to offer you assistance and also to offer you some advice. I do not know what the future holds out for you, but I hope very soon to be discussing plans with you of greater or less extent—which, we do not know. At any rate, you may be quite sure that we will always give you in this Society the greatest possible assistance and support. As to advice—I am not so sure. I think that it is far more likely that we shall be asking for it than offering it. It is my especial business to-night, on behalf of this audience, composed, I may tell you, nearly exclusively of Fellows of the Society, and on behalf of the Royal Geographical Society itself, to offer you our most sincere thanks for the actual lecture. I would also like to say with what intense pleasure we saw the very beautiful pictures which you put before us. With these few and most inadequate remarks I again ask you to accept our most sincere thanks.

BY AIR MAIL TO KENYA

MICHAEL A. UNWIN HEATHCOTE

[*We are indebted to Mr. Michael Heathcote for permission to publish these notes of a geographer on the air voyage to Kenya, not written for publication, but of interest both present and future.*—ED. *G.J.*]

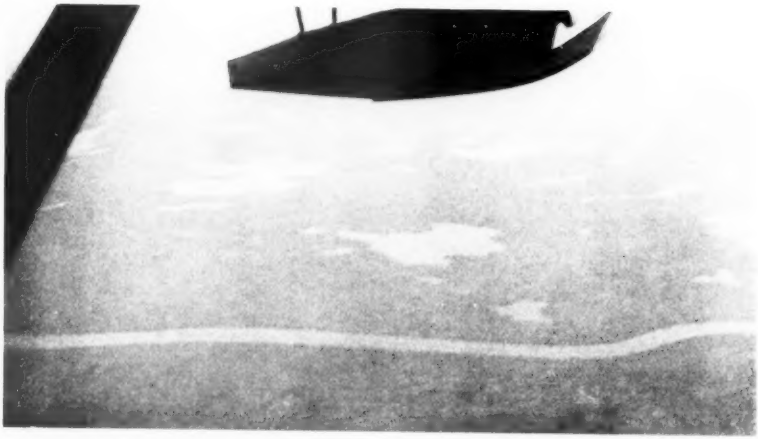
NOVEMBER 11, 1931.—We left for Croydon at 11.45, but as we got held up on Vauxhall Bridge for twenty minutes, it was already 12.30, and time to "take off," before we arrived there. At once we were bustled into the plane, and *Hanno* was actually in the air within eight minutes of our reaching the aerodrome. What a crossing! We bumped, and we rolled about and flew sideways in the gale. There were twenty-four passengers, and nearly all were past taking any interest in the flight. I thought it wonderful that the great wings held together. We flew only 700 feet above the Channel, which was very rough, as we could easily see. Once across and over France we had to fight every mile of the way. Near Abbeville a train almost overhauled us as we flew crabwise along the railway line. It was nearly 3.30 before we reached Le Bourget. At 21.30 we left the Gare de Lyon for Brindisi. We each had a single-berth sleeping car.

Thursday, 12th.—I slept not a wink until after Vallorbe, and awoke again at Lausanne. I always love that journey along the lake, and then up the Rhone Valley to Brigue. We passed through the Simplon about 9.30, and reached Milan at 12.30, after lunching in the train. After Milan it was a wretchedly slow train, and there was no restaurant car, so they gave us each a cardboard box containing—as some one put it—"cold chicken and toothpicks." It astonished me that no one seemed at all interested in the Swiss or Italian scenery; nor had any one else thought of bringing a map for the flight across Greece, and up the Nile. Some people could hardly see less if they travelled blindfolded.

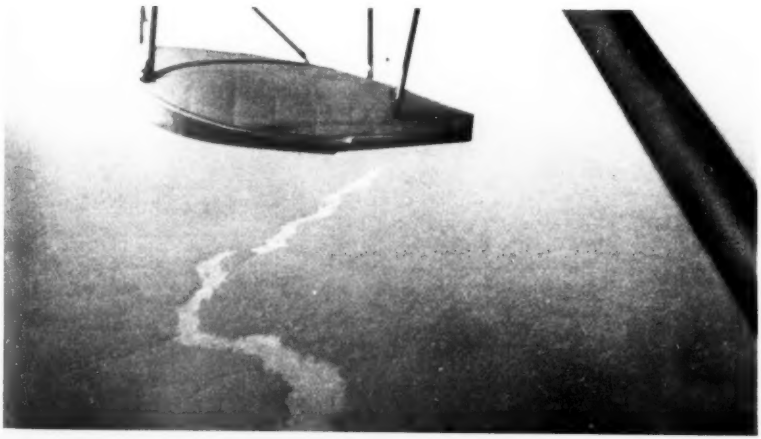
Friday, 13th.—On arrival at Brindisi, at 9.07, we went to a hotel for breakfast, and at 11 we boarded a motor boat and were taken out to the 4-engined *Kent* flying-boat, which was to take us to Athens. The space and comfort inside the cabin were astounding. We entered through a hatch opposite the baggage room. To the left was the control room, and to the right the passenger saloon, seating fifteen. The ship carried a crew of four—two pilots, a wireless operator, and a steward to bring us beer. There was an after-hatch for freight, giving access also to the roof, and a large amount of space in the tail.

We took off at 11.30. The thrill of it was wonderful, and the feeling of power was immense, as the engines seemed to grab hold of the machine and whisk it into the air. We flew at first quite low along the coast to the heel of Italy, and then set our course for Corfu. Corfu looked very pleasant and peaceful; at 2.35 we were passing Periboli, at the southern end of the island. At 3 we turned eastwards over Greece, and flew over a sort of inland sea, passing Salakhora, then Karvasaras, at the far end of the gulf, over a pass, across the river Aspro, and so to Lake Agrinion. From here we could see the Gulf of Corinth ahead of us, and once over this water we made for Corinth, which we reached at 4.30. While approaching the canal we met the S.S. *Helouan*, of the

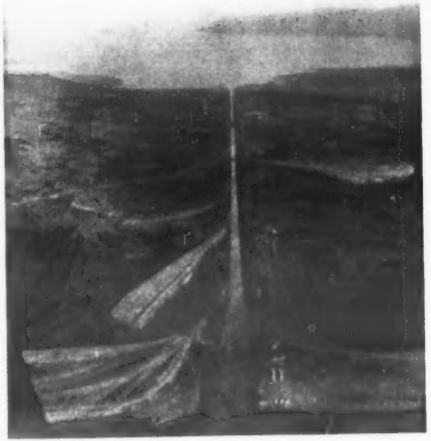
Looking north over Khartoum



Flying over the Sudd



The Victoria Nile



The Corinth Canal

Refilling at Station 6 in the desert between Wadi Halfa and Abu Hamed

Wadi in Upper Egypt

The Corinth Canal

Refilling at Station 6 in the desert between Wadi Halfa and Abu Hamed

Lloyd-Triestino Line, just coming out. I was surprised to see how short the canal seemed to be; we had left it behind almost before I had time to get a photograph. Salamis and Aegina next came into view, and at 4.45 we had circled over Piraeus and Phaleron, and come to rest in the bay. Passports and customs over, we were driven to the Hotel Grande Bretagne, which to my surprise proved to be most sumptuous and modern.

Saturday, 14th.—We left the hotel at 7.20, and took off just after 8, bound for Crete and Alexandria. At 9.40 I sighted the mountains of Crete, and forty minutes later we were over land again, flying at 2000 feet. We came down in a pretty bay called Mirabella, and went on board the depot ship *Imperia* for lunch. Bailey, our pilot, explained that it was very difficult to see the surface of the water, when about to land, as it looked like a sheet of glass. He tried throwing out some paper to see if that would help him. The island looked barren, and we noticed some queer-looking windmills, whose sails appeared to be merely poles, like the spokes of a wheel. The *Imperia* gives wireless aid to all aircraft in this region, and can sail to their assistance at two minutes' notice if necessary.

We took off again at 11.30, flew over a pass, and in a quarter of an hour had left the island behind. The sea was gloriously calm, and we could see for some 40 miles in every direction. We passed over three steamers, and a little later, at 3.15, the coast of Egypt was in sight. A quarter of an hour later we had swooped down over the harbour, and landed near the coal wharf. We then taxied towards the British Boat Club, and went ashore at a jetty next to it.

Sunday, 15th.—There was quite a mist when we arrived at the aerodrome at 7.20, so we waited half an hour till it was clear for taking off. We went aboard the waiting *Argosy* and found that things were not going to be nearly as comfortable as they had been. There was very little room, and the noise when we started up was terrific. We were in the air at 8, and rising at once to 1000 feet we crossed the Nile near Helwan. Cairo lay enveloped in the mist, but beyond the city there appeared two little orange-coloured pyramids resting triumphantly on a sea of clouds. We followed the west bank of the river till at Beni Suef we crossed again and flew over the desert on the other side. At 10.25 we came down at Assiut, and refilled our tanks. We left again half an hour later, and followed up the west bank, though away from the Nile. I began to realize now, on studying the map, that we should miss Luxor, and this was disappointing. For we cut off the big bend that embraces Thebes and Dendera, and instead had a very bumpy forty minutes over the sun-baked desert. But the view when we struck the Nile again was impressive, and I was delighted to be able to pick out the Luxor Temple, and the Colossi, with glasses. On we flew past Esneh and Edfu, though still over the desert, so that we bumped violently even at 4000 feet. I spotted the pylons of Edfu gleaming in the sunlight. At 2 o'clock we landed at Aswan. The heat here was stifling, and we pushed on as soon as possible for Wadi Halfa. We kept away to the west of the river, bumping considerably, and rejoined it at the bend just above Korosko. From here there is a camel track to Abu Hamed in the Sudan. It leads through a wilderness of sharp-pointed black volcanic rocks, with few wells and not a vestige of shade—a desolate and terrifying waste. Abu Simbil we passed at

4.25, and very soon we were over Wadi Halfa. We slept at the Government Rest House, a really delightful place on the river bank.

Monday, 16th.—We had breakfast at 5, and took the air at 6.10. The Cairo machine had plug trouble, and hadn't yet gone. We followed the railway across the desert, and came down at Station 6 for petrol. We passed Abu Hamed at 9.50, and by 11.30 were over Atbara, where we had lunch. The glare and the heat were tremendous. We were about to take off again an hour later when with a loud screaming noise the starboard tyre got punctured: I thought at first that the engine had seized. Changing the wheel occupied us for the next two hours, as the only implement for blowing up the new tyre appeared to be a bicycle pump. We took off again at 2.25 and reached Khartoum in two hours. In upper Egypt I had been very interested to notice how the rain, and also flood water, had left perfect river systems in miniature imprinted on the sand. And now, south of Atbara, there appeared trees in the Wadis, and the desert began to look green. There was a narrow fringe of cultivation along the river-side. At Khartoum baggage and mails had to be transferred to the flying boat. We went straight to the Grand Hotel, in time for tea.

Tuesday, 17th.—It was a dreadfully hot night, but I slept somehow. They called us at 3.45 with tea and an orange by way of breakfast. We drove to the river bank at Omdurman, where a motor boat was waiting. Everything was still as, like smugglers in the night, we crept aboard the *City of Stonehaven*, which lay tied up in mid-stream. Mechanics started the engines, and we were amazed to see tongues of blue flame spurting out of the exhaust ports. The petrol tanks were in the top wing, just above each engine, so that after that we thought the "smoking prohibited" notice seemed a little anomalous.

At 5 o'clock we could see the surface of the water, so the pilot took off downstream, and we climbed in a circle over Omdurman till we headed southwards. The sun rose at 5.48, by my watch, but it wasn't till ten minutes later that its rays were visible on the ground below us; and for longer still the shadows hung lingering in the west. Just after this I had a horrible sensation. I knew I had left something behind, and I suddenly remembered my field glasses: they were not in the plane. On reflection I remembered taking them out of the *Argosy* yesterday, and putting them down in a chair in my room. But this morning I never noticed them. At 7 we landed at Kosti, and I was able to send a wire to have them forwarded. We were given sandwiches here, for breakfast. At 7.35 we rose again and followed up the western bank, though often some distance from the river. The country was flat and open, with coarse grass and many *khors;* these are shallow depressions formed by flood water on its way to the river. In dry weather they become merely a bog, and you first realize their presence by suddenly finding yourself sinking, more and more with every step, into the mud as you force a passage through the 10-foot grass. An elephant however can cross without difficulty. Towards Malakal "bush" country appeared, and we landed for lunch at 10.20. We made fast to a raft in mid-stream, and here was petrol and oil all ready for refuelling. Passengers and crew were taken ashore in a motor boat to Imperial Airways Rest House. It was hot certainly, but nothing compared to Juba.

From Malakal we flew straight for the Bahr-el-Zaraf, which we met at a big

S bend near Taufikia, and then followed up this ever-winding stream, keeping it to our right. At 12.55, after only eighty-five minutes' flying, the Sudd began. It is an immense expanse of papyrus swamp, and the water-passage is an everlasting succession of hairpin bends, with innumerable blind alleys. No wonder that it takes three days by steamer to get through. We flew at 5000 feet over this region, passing Shambe at 1.50, and Bor—some distance off—an hour later. After that the ground rose visibly as we approached the Nyambara Hills; swamps and waterlogged bush land gave place to firm ground, and we began to look out for game. Soon we did see a lovely herd of giraffe; and another herd of what looked to me like tiang. An exciting moment occurred shortly before we reached Juba. Rejaf hill was already visible, and I was preparing to blow my nose and swallow furiously as we came down, when we all noticed a change of note from the engines—a sudden acceleration. Looking out to starboard we saw a hilltop only about 200 yards away, and just the same height as the machine. The wind was drifting us on to the hilltop, and it seemed as if the pilot was having a hard time to just scrape round to windward—though he refused afterwards to admit to any anxiety. But the very idea of a flying boat coming to rest on the top of a hill appeared so funny that any thoughts as to the consequences were not dwelt on. I used to think, in my ignorance, that a flying boat flew never very far from water, in case——; but I have now learnt better.

We landed at Juba at five minutes past four, having come from Malakal in three hours forty-five minutes, and from Khartoum in eleven hours. Last year I took ten and a half days on the same journey, going night and day, and stopping only for some fifteen hours on the way. Our speed over the ground was about 80 miles an hour, and the wind helped us slightly as far as Malakal. Juba seemed like a furnace when we went ashore close by the ferry. The hotel was much improved, though there was no ice or electric light yet; and the township had grown up like a mushroom.

Wednesday, 18th.—We were called again at 3.45. Unfortunately I slept on, and very nearly missed breakfast. As we were boarding the flying boat a boy fell into the river and had to be harpooned; we kept him in view meanwhile with a torch. There seemed to be some difficulty about how to take off this morning, and we taxied up to another mooring before attempting it. As we were taking off the port float seemed only just to miss an inquisitive hippo.

We left the water at 5.20, and headed for Port Liri, where we again met the Bahr-el-Jebel, or Mountain Nile, leaving Nimule some 25 miles to port. Shortly afterwards I was able to make out the northern end of Lake Albert, and we appeared, from our course, to be heading directly for the Murchison Falls. I sent a chit to the pilot asking if he could fly over them, as we were obviously so near. He replied that we should be pretty near—which I could see already. So we were, for we passed about 3 miles to the east, but saw nothing—except their whereabouts, for there was obviously a sudden drop and a gorge. I was very disgusted!

Ten minutes later, at 7.50, we suddenly spotted elephants, first two or three and then a herd of about twenty right below us. Later on an odd giraffe and some waterbuck were seen. We passed over the western point of Lake Kioga, and then followed along its southern shore for a bit, over swampy land, till

Victoria Nyanza came into view, and we turned southwards to Port Bell, landing at 10.15 (Uganda time), four hours twenty-five minutes after leaving Juba. We had lunch in Imperial Airways Office and Rest House, and took off again for Kisumu at 11.30, picking up one passenger and a load of fruit. The flight across the lake was uneventful, and I even slept for ten minutes—for the first time in the whole journey. Just before reaching Kisumu we passed over a tongue of land, perfectly flat, on which were a number of Kavirondo huts. Each family group of huts was surrounded by a ring of shrubbery, giving to the whole a bizarre and spotty effect from the air. We circled over the township of Kisumu at 1.40 and landed in the middle of the bay. On landing, the immigration officials made us do a lengthy examination paper, which occupied nearly twenty minutes. Nobody failed, I believe! The customs man was very troublesome over my gun, and we wasted over half an hour getting a permit from the D.C. before I could take it away.

We started off for Kitale about 4.30, and arrived soon after 11. Save for two hares and a jackal we saw nothing on the road.

THE *GAUSS* ANTARCTIC REPORTS

DEUTSCHE SÜDPOLAR-EXPEDITION, 1901–1903. Edited by ERICH VON DRYGALSKI. *Berlin: Walter de Gruyter & Co.* 1905–1931. Twenty Volumes and Two Atlases. 14 × 10 *inches; illustrations and maps*

WHEN the revival of interest in Antarctic exploration found full expression in 1901, the simultaneous expeditions of the *Discovery* and *Scotia* from Great Britain, the *Gauss* from Germany, and the *Antarctic* from Sweden were linked in a scheme of research which aimed at close co-operation in observations of a strictly comparable kind. Unfortunately the system of combining the results did not work so well as was expected; and from various causes the three expeditions went their several ways in discussing and publishing their reports.

The German expedition was placed under the command of Dr. Erich von Drygalski, who had already attained eminence as a Professor of Geography and as an Arctic investigator and glaciologist. He had the largest share in planning the expedition with the counsel and active help of Professor von Neumayer, Sir John Murray, and Dr. Nansen. He sailed in the *Gauss* and wintered in her frozen in the ice-pack off Kaiser Wilhelm Land, which he discovered, directing all the investigations which were carried on by an experienced staff. Since the return of the expedition in 1903, Professor Drygalski has devoted himself to working up the geographical results, superintending the discussion of the statistics and collections by specialists, and editing the Reports. After thirty years of toil he now has the supreme satisfaction of seeing his labours crowned by the publication of the completed work.

It is a magnificent achievement, but it leaves Professor Drygalski alone as the last of the leaders who pioneered the twentieth-century unveiling of Antarctica. Scott of the *Discovery* perished in the midst of a second and greater expedition, Bruce of the *Scotia* passed away with his Reports unfinished, and Nordenskjöld of the *Antarctic* died by accident before his results were fully worked up. Drygalski is left alone too as the last survivor of the scientific comrades on the *Gauss*. Bidlingmeier, the physicist, fell before Verdun in 1914; Vanhöffen, the

zoologist, succumbed to the hardships of life in East Prussia in t' e last year of the war, and their work had to be finished by other hands. Philippi, the geologist, who died of illness in 1910, had already practically completed the monographs embodying his work on the expedition.

The whole of the *Gauss* Reports are now before us in massive volumes of the largest quarto, finely printed and generously illustrated. They have grown in size and number far beyond the modest proportions originally planned. The first prospectus in 1903 spoke of ten volumes to be completed in five years; but only a few parts saw the light within that period. The delay in completion was due in the first place to the necessity of distributing the material amongst more than a hundred specialists, and the War when it came stopped all progress for a time. It is indeed remarkable that in the midst of the post-war depression and difficulties Professor Drygalski has been able to resume and finish the work. We cannot attempt to review critically such a series of Reports, encyclopaedic as they are both in matter and volume. The mere tabulation of the contents in the briefest form would absolve any reviewer from the presumptuous attempt.

As in the case of the *Challenger* Reports, the greater part of the work deals with marine biology and consists chiefly in the determination and descriptions of new species. No less than eighty-seven of Drygalski's specialists shared in the production of the thirteen volumes on Biology; and only sixteen, including himself, were engaged on the other seven volumes. Although the study of geographical distribution may be advanced by the zoological and botanical results of the *Gauss* expedition, the most direct contributions to geography are likely to accrue from the physical researches embodied in the first seven volumes to which alone this notice refers.

The only new land discovered by the German Antarctic expedition was a small section of the coast of the Antarctic continent named Kaiser Wilhelm Land, and the one exposure of bare rock was the little Gaussberg which rises through the snow to a height of 370 metres above sea-level. The winter quarters were in the ship herself, frozen fast in the sea-ice outside the Antarctic circle. Several sub-Antarctic islands were visited on the way south, and a subsidiary meteorological and magnetic station was maintained on Kerguelen. What the expedition lacked in extended surveys it made up for by the minute study of a small locality and the exhaustive discussion of all the results obtained. The question indeed suggests itself, as it has done in the case of many other expeditions, whether the publication of so many hundred pages of instrumental readings and calculations is justified in view of the great cost of printing and paper. So few inquirers are likely to undertake researches requiring reference to the actual original data that one is sometimes tempted to think that half a dozen copies made by direct reproduction of the MS. or typoscript might suffice, one set being preserved for reference in an appropriate institution in each of half a dozen countries. We do not stress the point in relation to this set of memoirs for it applies equally to a great number of cases, and after all the full publication of results is a fine tradition which in this instance has been nobly upheld. One word of adverse criticism I do venture to say, and the less reluctantly because it applies with equal force to the completed Reports of many British expeditions. It refers to the want of an alphabetical index to each volume of text, a want which makes the comparison of the detailed results of any two expeditions laborious beyond endurance.

Volume I of the *Gauss* Reports, "Technical and Geographical," begins with a full description of the ship and her equipment with large-scale drawings showing all details of hull and rigging, such as we should like to see of the *Discovery* but miss from the records of that expedition. Then follows an exhaustive account

of the astronomical determination of position and the rating of the chronometers, and a discussion of the pendulum observations for gravity. The volume concludes with an elaborate memoir on Antarctic ice published in 1921, in which Professor Drygalski makes an important contribution to science, deserving comparison with Priestley and Wright's volume on Glaciology published about the same time in the Reports of the *Terra Nova* expedition.

Volume II, "Geography and Geology," contains seven memoirs, each consisting of a geographical description followed by geological and petrological discussions of the Gaussberg and various sub-Antarctic islands. The Gaussberg is mapped on the scale of 1 : 7500 and contoured at intervals of 10 metres by means of Finsterwalder's photo-theodolite. Kerguelen is described by E. Wirth, with geological chapters, as for the Gaussberg, by Philippi and Rheinisch. This is accompanied by a general map of Kerguelen on the scale of 1 : 200,000 and smaller maps showing the distribution of permanent snow and glaciers. A striking coloured picture of Mount Ross gives an idea of the subdued tints of the vegetation. The remaining sections deal in a similar way with Heard Island, the Crozets, St. Paul, and New Amsterdam. The volume concludes with a Report by Philippi on marine deposits brought up by the sounding tubes throughout the cruise and with the rock debris collected from icebergs.

Volumes III and IV deal with the meteorological observations as worked up by Dr. W. Meinardus, who included the *Discovery* results in his general account of Antarctic meteorology and whose conclusions have since been dealt with by Dr. Simpson in his great treatise on the Meteorology of the *Terra Nova* expedition, while Professor Meinardus comments here on Dr. Simpson's views. Meinardus and Mecking worked up more than half a million observations of the International Co-operation into nearly one thousand maps, showing, amongst other data, the isobars of the Southern Hemisphere south of 30° S. for every day from 1 October 1901 to 31 March 1904. These charts form the Meteorological Atlas which, if it could be bound in one volume, would be 4 inches thick.

Volumes V and VI contain the observations on terrestrial magnetism at the *Gauss* station on the ice, at Kerguelen, and on the ship during her voyage, together with full details of the methods of observation and discussion, and the Atlas reproduces the graphs of the recording instruments. Volume VII includes contributions on Hygiene and Bacteriology; but its largest and most important memoir describes the Oceanographical work of the expedition and the chemical investigations associated with it.

The advance of the observational sciences has been rapid in the generation since the *Gauss* fared forth on her voyage. Much which it was then a feat to accomplish, such as fixing longitude, making deep-sea soundings, photographing from the air (the *Gauss* got some air photographs from a balloon), and photographic surveying, are now matters of mechanical routine. Nevertheless there is much in the experience of the investigators, their methods and their results, that remains of moment to the polar explorer of the present day. Professor Drygalski has been himself the chief contributor to this result, and he deserves, and will receive, the heartiest congratulations of geographers in every country on the happy outcome of his labours. H. R. M.

REVIEWS

EUROPE

TRAMPING THROUGH WALES IN SEARCH OF THE RED DRAGON. By JOHN C. MOORE. *London: J. M. Dent & Sons*, 1931. 7×5 *inches;* xii+212 *pages; illustrations.* 6*s*

It is not every one who cares to walk by himself carrying on his person up hill and down dale tent, sleeping bag, primus stove, and sundry other gear. Even Mr. Moore grew tired of his load and was not above covering long stretches by motor or on horseback. The wrapper, in stating that this book "is the result of a walk of about 400 miles all over Wales," must have thought of a number, doubled it, and perhaps then added something. But there is no map, and the author is a little vague about geography; at the source of the Usk "it was strange to think that this bubbling spring was the origin of the lovely river which winds down to the estuary of the Wye. . . . Above Tintern it tried to drown me once." A strange conception indeed; but he disclaims the possession of "the qualities that make a reliable guide," and writes amusingly of the mild adventures of which, rather than of the Red Dragon, he was in search. But if he tries to make himself as much like a gipsy or travelling tinker as possible, he should not resent being treated as such. He makes some scathing remarks about Welsh chapels and hotels and draws a masterly picture of "that horror" Rhyl. There is nothing specially original or noteworthy about the photographs. J. H. R.

THE ADVENTURE OF THE FAEROE ISLANDS. By M. HELEN GRAHAM. *London: Arthur H. Stockwell.* 7×5 *inches;* 38 *pages; illustrations and map.* 2*s*

This modest volume may not be a literary gem; but every yachtsman must take off his cap to the seventeen-year-old authoress and "mate," who alone with her father and "skipper," Commr. R. D. Graham, sailed a 7-ton cutter from Bridgwater to the Faeroes and back, 1718½ miles (the ½ being in the River Parret). To the mere landlubber this seems a superhuman undertaking; but evidence that after all Miss Graham is only human is supplied by one of her father's "technical notes," which reads: "Mate was instructed in use of sextant, but would use the index glass as a mirror in which to admire herself." It would be ungracious to criticize this vivid and charming little narrative; but we might not unreasonably demand that the map of the islands should show all the place-names mentioned in the text. The Faeroese names, by the way, receive kinder treatment than the British; we venture a mild protest against "Lock Erisfort." We will also hazard a guess that a note with the words "ei kan laik ju veni ves" signed by a Faeroese swain and subsequently found in the pocket of a blouse was intended to be an expression of admiration in the English language ("veni ves" being emended to "veri vel"). J. H. R.

DANIEL VETTER A JEHO "ISLANDIA." By BOHUSLAV HORÁK. *Brno; Faculty of Philosophy, Masaryk University* 1931. 9×6 *inches;* 214 *pages;* 3 *plates and* 2 *sketch-maps. Kč.*35

The seventeenth-century account of Iceland by the Moravian Daniel Vetter (or Strejc, the Czech name of which Vetter is a German translation) is little known in this country; but Thoroddsen noticed it at length in his 'Geschichte der Isländischen Geographie,' Leipzig 1897, II, 205–219. Vetter, with a Moravian companion named Jan Salmon, sailed from Bremen on Ascension Day 1613, and landed on the north side of the Snaefellsnes peninsula somewhere in the neigh-

bourhood of the historic Helgafell of "Eyrbyggja Saga." His route through Iceland is not very clear; but according to the map in this volume he followed the line of the present road south from Stykkishólmur across the Snaefellsnes range and the plain of Mýrar to the river Hvítá, and thence the inland track to Thingvellir. Proceeding to Skálholt he was entertained by the bishop there and then turned westwards to the coast at Bessastaðir near the modern capital Reykjavík.

His 'Short Description of the Island of Iceland' was published some years afterwards in three languages: in Polish at Leszno (German Lissa) in 1638, in German at "Leucopolis" (German Weisskirchen, Czech Hranice) in 1640, and in Czech at Prague in 1673. All three texts are here given in full with reproductions of the original title-pages; but the Czech text is taken from the manuscript dated 1638 in the library of the National Museum at Prague. Leszno, in Poland, was the refuge of many Bohemian and Moravian exiles, and it was here that Vetter married Kristina Poniatowska, the foster-child of his famous compatriot Komenský, who settled there in 1628.

Vetter's journey to Iceland was a remarkable achievement for a Central European at that time, and he was deeply interested in the "things strange and singular" that he saw there. His [Czech *Jeho*] "Islandia," which runs to a score or more of pages in this book, deals with the name of Iceland, religion and government, the nature of day and night ("very different from ours"), mountains, waters, animals, birds, roads, industries, houses, the people, adjacent islands, and fish and marine monsters. Professor Horák adds notes, gives some account of Vetter himself and his journey, and discusses the three texts; but all this of course is in Czech. Readers acquainted with German but not with Czech will be glad to have Vetter's own German version here and can refer to Thoroddsen *loc. cit.* for further particulars. J. H. R.

SLOVAKIA THEN AND NOW. By MANY SLOVAK AUTHORS, arranged by R. W. SETON-WATSON. *London: George Allen & Unwin*, 1931. 9×6 *inches; 356 pages; illustrations and map.* 12*s* 6*d*

This collection of five-and-twenty essays by prominent Slovaks, assembled and introduced by Professor Seton-Watson, is described as "A Political Survey," and only incidentally touches on geographical matters. But while dealing mainly with administrative, judicial, economic, social, and religious problems, the book includes chapters on such subjects as literature, art, and music; and the cultural progress of a people may be admitted into the sphere of human geography. There is, of course, one burning geographical question in Slovakia—the question of the southern boundary. "The answer," says the Professor, "may be summed up as follows. The task of providing perfect ethnographic frontiers for Hungary is as impossible as Shylock's problem of separating flesh and blood. Whatever the frontier drawn, ragged edges are inevitable: in other words, considerable racial minorities must remain on the wrong side of it. . . . A return to the historic frontiers being inacceptable to every race save the Magyars, and a perfect racial frontier being unattainable, any further tinkering at the admittedly imperfect line drawn in 1918–20 would only deepen existing feuds and provoke another general conflagration." He considers at some length the grievances of the Magyar minority in Slovakia and shows that a good deal remains to be done towards their satisfaction. But "by comparison with the political rights which the Slovaks enjoyed in pre-war Hungary, the rights of the Magyars in Czechoslovakia are generous in the extreme." He goes so far as to say that "the defeat of the Entente in the Great War would have meant the virtual destruction of Slovak nationality in the course of another generation." The amazing revival of

this stunted and oppressed people in all departments of life is the theme that runs through the whole book. This could not have been achieved without the help of the more-favoured Czechs, of which these Slovak authors make frequent and unstinted acknowledgment. That there has been a certain amount of friction is not denied; but it has often been aggravated by Magyar intrigue. The Slovaks suffered a great loss by the death in 1919 of their leader, General Štefánik, and lacked a strong guiding hand at a most critical period.

The work was published in English and Slovak simultaneously, and the former edition was printed by the Orbis Publishing Company at Prague—a fact that accounts for a number of typographical errors. The photographs of places and persons, mostly collected at the end of the volume, are excellent. The well-known 1/2M map of the whole republic is included. J. H. R.

FRANCE : a regional and economic geography. By H. ORMSBY. (Methuen's Advanced Geographies.) *London: Methuen & Co.* 1931. 9×5½ *inches;* xiv +516 *pages; diagrams and maps.* 21*s*

A geographer making a study of France has to choose a point of view, and Dr. Ormsby has chosen hers in such a way as to avoid any large overlap with some well-known books. M. Vidal de la Blache wrote his famous classic primarily for French students, and made the relations of structural and physiographical features to the life of the people the keynote of the regional portion, after dealing brilliantly with the personality of France. M. Brunhes developed the study of cultural features of houses, villages, and towns with much attention to the geography of history. Either standpoint might have been taken by a foreigner in a work written for those who study France from outside, but a book on those lines would challenge comparison with those well-known books based on intimate knowledge of their own country's life by distinguished students. Dr. Ormsby's publishers refer to her study as a picture of the economic life of France, and, if for economic we read commercial, this is a valid description; it indicates not only that the authoress has adopted a position of her own which she maintains with characteristic firmness, but also that her work deals especially with the commercial exchanges, internal and external, that accompany the life of the French people. The internal commercial exchanges are very important in a country like France, which, traditionally and on principle, looks upon external commerce as a secondary matter. Behind them all however is the large fact that so much French energy goes into farming for the production of what the farmer and his family themselves need. This fact makes the commercial rather distinct from the economic aspect, and distinguishes France quite sharply from some other countries, and notably from ourselves.

Nearly three-quarters of the book is taken up by a set of regional studies, to each of which is affixed a bibliography that, in the case of French districts, is of special value, because of the amount of attention French geographers, and their leading journal, the *Annales de Géographie*, have paid to the description of the districts of France. This main part of Dr. Ormsby's book is preceded by a general introduction which deals principally with climate and is followed by sections studying agriculture, industry, and communications.

Dr. Ormsby reduces historical references as much as possible, but, in her discussion of Paris, she rightly starts out from the fact that the Romans were concerned quite as much or more with ways through Gaul to Britain and the Rhine, and that consequently Chartres on the way to Rouen and the Channel, as well as Reims on the way to Belgium, were rather more important centres of communications, and it was with the rise of the individuality or the personality of the Seine–Loire basin on its own account that Paris later attained its out-

standing position. The extent to which Paris does dominate France is not a subject within the authoress' plan of study.

The importance of subsistence farming in France has been suggested above, but Dr. Ormsby very justifiably draws attention in her chapter on agriculture to the ways in which even the French peasant, for all his self-contained system, has reacted to outside influences. Improved methods of cultivation and the possibility of a supplement of foreign grain led to a reduction of the wheat area in France, which nevertheless remained very large, thanks to the reasonable assurance of sunshine and to import tariffs. Possibilities of refrigerated meat, again, encouraged specialization on dairying; but, again, local supplies remained supremely important, as every visitor to France knows from the importance of veal in the menu. France, like ourselves, is feeling very seriously the drift to the towns, accelerated as a result of the war of 1914–18, which stirred many a peasant youth out of the routine that previously had been assumed to be his path in life, and Dr. Ormsby is specially right in insisting on the drain that the war exercised on French manhood, though she does not give much space to demographic considerations in general. The section on wine production is well done; it brings out the distinction between the generalized production, especially in Languedoc, and the high specialization in various special localities of the Paris basin which have the requisite dry soil on a limestone foundation and the sunny aspect favoured by the vine. The section is a little short, but Dr. Ormsby obviously had to be very summary in her treatment in order to cover the whole subject in the detailed way that her general plan implies.

The development of industry in France is peculiarly interesting. Dr. Ormsby sees that it was going on in the early years of this century, and of course that the return of Lorraine to France has made it much more important, while she also refers to the help that the application of hydroelectric power has given to local industries in the uplands. The persistence of industries for many centuries in the same spot, dealing with what we should call small quantities of material, is a feature of France, and the reviewer sees it exemplified, as it were *par excellence*, in the tannery that still, nine hundred years after William the Conqueror's birth, is carried on on the site of his mother's home beneath the castle at Falaise and in the still-continuing leather fair of Guibray near by which he founded in honour of his mother. Local continuity in spite of political revolutions, a large measure of persistence of a mediaeval economy, a maintenance of the age-old idea of society as a trusteeship handed along the generations are features of French life that we in England sometimes find it difficult to allow for in discussions that bring out resultant divergences of view between Frenchmen and ourselves in current affairs. Knowing the urgent need for the promotion of better mutual knowledge, one could wish that Dr. Ormsby had found a little more space for these aspects of study. One can but hope that the success of her book with its masses of valuable information will be such as to encourage the preparation of a new edition that will add a chapter of generalizations, in which comparisons with other lands may find a place and in which the importance of the road in French life and thought, past and present, may receive more attention. The value of the book is immensely increased by the fact that Dr. Ormsby has obviously visited the great majority, if not all, of the districts and places mentioned, and by the fact that she has prepared a large number of original maps. This is no hastily compiled essay, but a building the bricks of which have been amassed by steady work; and the authoress has chosen an architectural composition of her own. There are naturally points here and there which different writers would express differently, but within the chosen limits it is to be warmly welcomed and, one hopes, will be widely used. H. J. F.

AFRICA

CAPE TO COWLEY *VIA* CAIRO IN A LIGHT CAR. By M. L. BELCHER. *London: Methuen & Co.* 1932. 7½×5 *inches;* xvi+238 *pages; illustrations and sketch-map.* 8*s* 6*d*

Miss Belcher claims nothing for her last year's motor journey from South Africa to England in a 1924 model Morris Oxford, except that it was undertaken as a holiday tour with a desire to show what British goods could do. What they did was to transport two women (and a third for the first part of the journey) with all their equipment 10,000 miles in six months over roads which were sometimes almost impassable and seldom good until Europe was reached. And the drivers are to be greatly complimented on their success.

After crossing the Zambezi (their car was the first to cross the new Victoria Falls bridge from south to north) the route followed was the familiar one by Broken Hill, Dodoma, Nairobi, Juba, and the Nile, the only places in Africa where the car was put on to a steamer being between Juba and Khartoum and Wadi Halfa and Shellal. Difficulties are made light of; weather hold-ups are treated with commendable patience, and night-time visits from lions with "masterly inactivity"; stories of native and animal life are enjoyed and retold, and everywhere the adventurous couple were welcomed enthusiastically, especially where there happened to be companies of girl guides, since a presentation brass trefoil adorned the car's bonnet.

The tale is modestly and humorously told, and shows a determined cheerful spirit. The photographs are clear and the map adequate. E. W. N.

HISTORICAL OUTLINE AND ANALYSIS OF THE WORK OF THE Survey Department of Kenya Colony, 1 April 1903 to 30 September 1929. By J. H. WILLIAMS. *Nairobi: Government Printer* 1931. 8½×5½ *inches;* vi+118 *pages; maps.*

In this small volume Mr. J. H. Williams gives an outline of the history of the short-lived Survey Department of Kenya Colony—formed in December 1905 and abolished in March 1921. To those who believe that adequate surveys are an invaluable aid to administration and progress, it is somewhat melancholy reading, being a conspicuous example of the fact that survey departments are among the last to be formed by administrations, and among the first to feel the axe when the stress of economy comes. A foreword by Brigadier Winterbotham explains the value of such records as this. The account is divided into five chapters, which discuss respectively the evolution of the Department, Boundary Surveys which have been incorporated in the general survey of the colony, trigonometrical work, topographical surveys, and cadastral work. These are followed by ten appendices which contain various reports and other matters of interest, and include two diagram maps.

The colony was taken over from the Imperial East African Company in 1895, but it was not until eight years later that the first semblance of a survey staff appeared, as part of the Public Works Department, in the persons of one chief surveyor and one Indian clerk. At the end of 1905 a properly organized Survey Department was formed, the first Director being Lieut.-Col. G. E. Smith, R.E., who had previously reported on the survey situation and recommended the organization. For some ten years the Department flourished and turned out excellent work. Then the war intervened, and the break-up began immediately after. In 1919 the Cadastral Branch was absorbed in the Land Office; in 1921 the remainder of the Survey, consisting of the Trigonometrical and Topographical branches, was totally abolished. The present position is that the

"Surveyor-General" is the officer in charge of cadastral surveys and land registration, while other survey work is practically non-existent. From figures given in Chapter IV it appears that about half the triangulation necessary to cover the colony has been done, and rather less than one-third of the topographical work. Much therefore remains to be done, apart from revision of work already published.

While regretting that economic pressure has made it necessary to abolish this Department, to the excellence of whose work the Colonial Survey Committee has testified, one's thoughts naturally turn to the possibility of its revival some day. The colony must obviously be properly surveyed; the only question is when, and under what conditions, renewal of the work will be practicable. Cost will no doubt be one of the prime considerations, and in this connection Appendix 10, by Brigadier Winterbotham, on the training of African surveyors, is of great interest. The training of native surveyors on the West Coast has been attended with considerable success and a great saving in cost. No serious attempt to grapple with this question seems to have been made in East and Central Africa, yet it is surely in this direction that the only hope lies of getting the survey going again. When Colonel Hills made his Report, in 1907 (Appendix 3), the idea was current that the East African native was incapable of doing any skilled work; but much has happened since then, and it is to be hoped that such ideas are no longer held. In the opinion of Brigadier Winterbotham, a most competent judge, there are plenty of natives in the central area of Africa who provide just as good material as those of the West Coast. It would seem that if this matter were seriously taken up, on the lines found so successful in West Africa, and always remembering that it is essential that formation of character, by strict discipline, should go hand in hand with the technical training, there might be reasonable hope that the task so excellently begun by the Survey Department of Kenya will without too long delay be completed. E. M. J.

THE NILE BASIN. By H. E. HURST and P. PHILLIPS. Volume I. General Description of the Basin, Meteorology, Topography of the White Nile Basin. (Ministry of Public Works. Physical Department Paper No. 26.) *Cairo* 1931. 11 × 7 *inches;* xii + 144 *pages; illustrations and maps. P.T.*50

In 'The Physiography of the Nile,' published in 1906, Sir Henry Lyons gave a very complete account of all that was then known concerning the topography, climate, and hydrology of the Nile. But the scientific investigations which he initiated have been continued and extended, and a much greater series of accurate observations is now available. The present volume, in which the results are summarized, is the natural outcome.

It begins with a short chapter on the history of discovery in the Nile basin in modern times. Then follows a brief general description of the basin, which includes a very interesting table of monthly mean discharges at various points upon the river and its tributaries. About forty-five pages are devoted to meteorology, and this chapter is illustrated by an admirable set of maps and diagrams which show the regional and seasonal variations of the various climatic elements very completely. There is also a section on the influence of climate on vegetation with an excellent series of photographs of different vegetation types. About forty pages are given to the topography of the White Nile basin. For purposes of description the area is subdivided into (1) the Lake Plateau basin; (2) the Bahr el Jebel, Bahr el Zeraf, and Sudd region; (3) the Bahr el Ghazal; (4) the Sobat basin; (5) the White Nile, below the junction of the Bahr el Jebel and the Bahr el Ghazal. The characteristic features of each region are shown in a number of well-chosen photographs.

The text is clear and concise, and the arrangement so plain that it is easy to look up any point on which information is desired. With its wealth of illustration the book is ideal as a physical description of the region concerned. From the point of view of the teacher or the student it is as nearly perfect as human limitations allow, and there is an excellent bibliography for those who require anything more. P. L.

A GAME WARDEN AMONG HIS CHARGES. By Captain C. R. S. PITMAN. *London: Nisbet & Co.* 1931. 9×5½ *inches;* xvi+330 *pages; illustrations and map.* 16*s*

Captain Pitman is well qualified to give an account of the game animals of Uganda. Not only has he been the official game warden of the territory, but he is a naturalist with wide experience in several different parts of the world. In this book he records many interesting facts with respect to the habits of the wild game and gives a pleasing account of some of his journeys in the least-known parts of the territory. He tells us much, for example, of the white rhinoceros, an animal of which every detail is worth record, since it may be said to be on the very threshold of extinction. His observations on man-eating lions are impressive, and there is an immense amount of new information on the imperfectly known habits of the crocodile. Nor has he neglected the smaller creatures which, though less noticed by the ordinary sportsman, are of equal interest to the student of nature. The gorilla receives due and deserved attention; it is reassuring to learn that in British territory the animal is adequately protected for the present, but it cannot be regarded as permanently safe until the area that it occupies is established by legislation as a permanent national park. But his book is not only for the serious naturalist; there is much in it to captivate the mind of the sportsman, such as the exciting narratives of his hunting experiences with buffaloes, rhinoceroses, and elephants. But we are frankly surprised at finding less about the elephant than we might have expected from Captain Pitman. He has been the controlling agent in the elephant destruction that has been carried to such alarming perfection in Uganda. His experiences in this matter must be altogether unique, and no doubt he is retaining them for a future work which we look forward to as a remarkable volume. R. W. G. H.

NORTH AMERICA

STREAM SCULPTURE ON THE ATLANTIC SLOPE: a study in the evolution of Appalachian rivers. By DOUGLAS JOHNSON. (Columbia Geomorphic Studies.) *New York: Columbia University Press* (*London: H. Milford*) 1931. 9½×6 *inches;* xxii+142 *pages; diagrams and maps.* 22*s*

It is now nearly forty-two years since Professor W. M. Davis published his classic paper on the Rivers and Valleys of Pennsylvania in which he gave to geographers not merely the first systematically reasoned study of Appalachian river history, but a major contribution to our understanding of the history of rivers in general. At that time Powell's idea of antecedence was much used to explain such discordance between streams and structure as is strikingly exemplified in the Appalachians. But Professor Davis broke new ground by investigating deductively the probable evolution of the drainage system. Beginning with the river system that must have been consequent upon the original Appalachian folding, and supposing it to be modified only by spontaneous adjustment to structure, he arrived at a river system so like the present one that he was led to consider his original assumptions justified. He was therefore able to reject the idea that the streams were antecedent, but the alternative idea of

superposition did not occur to him as applicable on such a scale, although he made use of it to surmount one of the most difficult obstacles in the way of his theory. This is perhaps the more remarkable when one remembers that as early as 1862 Jukes had employed the idea of superposition—though he neither named nor defined it—to explain the remarkable discordance between the rivers and the essentially Appalachian structures of Southern Ireland.

This last theory of drainage evolution has now been applied to the Appalachian rivers by Professor Douglas Johnson of Columbia University in his latest book. One is naturally prejudiced beforehand in its favour, since, on the one hand, antecedence is nowadays regarded as an idea of relatively limited application, while on the other, the complexity of the Davisian hypothesis renders it difficult of acceptance. But Professor Johnson presents his case with such thoroughness that one is left in no doubt as to its superiority over the older theories. He is not concerned with the earlier phases of Appalachian drainage evolution, but begins, in a sense, where Professor Davis left off. For so much have our ideas of geological chronology expanded during the last forty years, that the events for which Professor Davis required the whole interval between the Appalachian revolution and our own times could not now be regarded as capable of filling that interval. Much of the evolution that he imagined must actually have taken place, but its result was not, as he supposed, to produce the present river system, but rather, if we follow Professor Johnson, that which flowed over the Fall Zone peneplain, and was later extinguished beneath a blanket of Cretaceous coastal plain sediments. Subsequently, a broad-arched uplift with an axis unrelated to the Appalachian fold-belt, and in the north far west of it, initiated a system of south-east flowing streams whose descendants to-day occupy southern New England and the Central Appalachians. Since that time the unconformable cover of sediments has been stripped away and the extraordinary diversity of the undermass reduced by early Tertiary times to a true peneplain of great extent and very subdued topography. This peneplain is still visible in the summits of Kittatinny and Schooley mountains, after which it is variously called, as well as in the Appalachian ridge crests generally, and in the plateaux surfaces of the highlands of southern New England. Since its uplift insufficient time has elapsed for the completion of a whole erosion cycle and the production of a true peneplain. Nevertheless, more than one base-levelled lowland has been opened out on the weaker rocks, facilitating greatly the adjustment of streams to structure already well advanced in the Schooley cycle.

The history thus outlined occupies relatively small space in the book; far greater attention is given, first to the considerations that have led to its adoption as a working hypothesis, and secondly to the applications of the theory to some Appalachian problems of long standing. This latter portion makes the most interesting reading in the book, for the earlier chapters are marred by a style somewhat reminiscent of a catalogue. Particularly inspiring is the convincing recreation of the long-vanished belted-lowland topography in which a subsequent lower Hudson became superimposed upon the trap ridges of New Jersey. The simplicity of the idea and the marshalling of the evidence are alike masterly.

Indeed, it is its simplicity most of all that renders Professor Johnson's conception of superimposed drainage so useful and so attractive. Davis was forced by the nature of his hypothesis to find separate explanations for each individual case of stream discordance with which he had to deal. But it is one of the merits of the new hypothesis that it provides at once a uniform explanation for all such cases. The reviewer feels that it will in all probability be found applicable, not merely to the Pennsylvanian rivers, but to the drainage of the whole Atlantic slope from the St. John to the Savannah. The book thus constitutes a new point

of departure in Appalachian research, and every geographer who cannot read it in full should examine closely the fine line drawings from the pen of Dr. Raisz (especially Figs. 1 to 9) which present in graphic form the essential features of the theory. D. L. L.

AUSTRALASIA AND PACIFIC

HUNTING INSECTS IN THE SOUTH SEAS. By EVELYN CHEESMAN. *London: Philip Allan & Co.* 1932. 9×5½ *inches;* xii+244 *pages; illustrations.* 10*s* 6*d*

Miss Cheesman's books are always interesting. She is one of the few naturalists who visit the tropics, not merely to amass large collections, but to record observations on the instincts and behaviour of the small creatures that are her special study. In this book she takes us to the Pacific Islands and introduces us to the most striking of their insect inhabitants. We are told about the wasps and their nest-building instincts, the remarkable way in which they paralyse their victims and how they store them in their mud cells. We are given many facts about the moths and butterflies, especially on the way their caterpillars intimidate enemies by assuming the appearance of venomous snakes. We learn about the breeding habits of sawflies and mosquitoes, the protective devices of mantids and stick insects, the illuminating powers of fireflies, the leaf-cutting operations of solitary bees, and the habits of those remarkable grasshoppers that seem as much at home on the water as on the land. The author also records her special adventures while camping and climbing and wandering in the islands. The field naturalist will welcome Miss Cheesman's book. He will find in it many facts of interest and will see in her photographs and insect sketches how faithfully her observations are recorded. R. W. G. H.

DOWN UNDER: an Australian Odyssey. By R. W. THOMPSON. *London: Duckworth* 1932. 9×5½ *inches;* 304 *pages.* 12*s* 6*d*

There is so much that is interesting and valuable in this book that it is worth while to overlook the irritation induced by the first chapter in which there are a slightly contemptuous reference to the author's mother, many crude words and images intended to accentuate his freedom from "Victorian hypocrisy," and an unpleasant description of hate at first sight towards the working-men of Australia. The two main elements of the book are a description of the surroundings in which an educated immigrant young Englishman works in New South Wales, and an attempted revelation of the writer's character. From the first of these elements the reader is able to get, probably better than from any other source we know, a picture of many aspects of Australian life. The economics of wool are briefly and clearly explained. Vivid pictures are given of the various operations on a large grazing station—of the marking of lambs; of the mustering, counting, dipping, shearing, and trucking of sheep; of the mustering and droving of bullocks; of the homestead where lives the harassed manager and the hard-working and ill-paid jackaroo; and of the squalid hut that shelters the boundary rider and his poor family. We are told of what happens on a sheep station in a drought and when it breaks; of fighting a bush fire; of rapid travelling along bad roads and tracks in much-knocked-about American cars; of recreation at the station, in the small township, and in the big city. The author's experience of life in Sydney takes him into the insurance business, into mining speculation, and into salesmanship of various articles, ultimately of gramophones, until that is upset by tariffs. He visits Newcastle on a holiday; deplores the foolishness that has led to the decay of coal-mining there, and enjoys himself bathing, fishing, and seeing prize fighting under novel conditions. All these descriptions are excellent, showing

great powers of observation and of recording what is observed. This power of record, applied to the author's human surroundings, leads him astray, for momentary impressions are put down which are undoubtedly modified, if not cancelled, by maturer consideration. It is evident that in a number of cases those with whom he was brought into close contact revealed themselves to him as possessing lovable characters. As regards the generality, he seems to have been somewhat unnecessarily upset by the unimportant boastfulness of the Australian with regard to everything in his country, and to have put it down to an inferiority complex. There are other characteristics that annoyed him, and appear to have given him the impression that the farther one gets from the great cities of Australia the more attractive are its men. It is unfortunate that in these circumstances his experience was confined for the most part to Sydney, Newcastle, and the country between them. His impressions would have been somewhat different had he been much in the western and northern parts of Queensland, where the larger proportion of the population live on the land and possess the physical and some other of the characteristics that he admires. He would probably have formed in that case also a different view from that which he seems to hold of the power of Australia to support a great population. Whereas it is quite possible that a station like Minembah in New South Wales, where he worked, which can carry a sheep to the acre, could be turned into farms, such conversion is obviously impossible in the light-carrying country with small rainfall and often poor soil which constitutes a great part of Australia. The enormous stations in Queensland requiring 15 to 20 acres for a sheep and five times this area for a bullock obviously cannot be thought of in connection with any form of closer settlement. The author might possibly also have taken a more favourable view of the white Australian policy if he had seen the cane-cutters in the tropics bringing to their work the same strength and energy that characterize the shearers in the south and west, and if he had had experience in other lands of the difficulties that arise when a coloured race is introduced into a white man's country as a labour force.

The second main element of the book, the author's attempt at self-revelation, is so far from being of geographical interest that it is only necessary to say in this review that every now and again his sense of humour pierces through his confidence in the rightness of his own views and in the correctness of his reading of his own mutable character. The book will give annoyance to many and pain to a few Australians; the latter are those who will realize that there is a modicum of truth in some of the author's criticism of the characteristics of their countrymen. But every fair-minded reader will recognize Mr. Thompson's great descriptive power and will look forward to the publication of other books which will give him that material success that one side of his character craves and an outlet to the desire to be true and natural which he claims to be the other part of his dual personality. M. N.

THE LOST CONTINENT OF MU. By Colonel JAMES CHURCHWARD. *London: Rider & Co.* [N.D.] 9×6 *inches;* 336 *pages; illustrations and maps.* 15*s*

THE CHILDREN OF MU. Same author and publisher. 9×6 *inches;* 266 *pages; illustrations and maps.* 15*s*

Some fifty years ago, he tells us, the author discovered, with the aid of "the high priest of a college temple" in India, but at a place unspecified, a large series of clay tablets with characters in "a dead language my priestly friend believed to be the original tongue of mankind." He gives no representation of any tablet, but pages of characters (he calls them vignettes) of which no. 19 on p. 22, depicting man's advent on earth in the land of Mu, would convince any one. There are ten series, the longest of only sixteen tablets, yet series three treats of the origin

and working of the great forces throughout the universe. The Motherland of Mu was in the Pacific. It had sixty-four million highly civilized white inhabitants, and was destroyed by volcanic eruptions due to subterranean gas-belts; but a few fragments survive in Easter Island with its images, and the Carolines with their monuments. The Athenian alphabet, as rearranged in 403 B.C., is an epic composed of Cara-Maya vocables, commemorating the catastrophe (p. 104). There are accounts also in the Record discovered by Schliemann in the old Buddhist Temple of Lhasa. The theory of evolution is untenable in the face of the sacred writings of Mu, more than fifty thousand years old, which inform us however on the nature of the electron. But the treacherous gas-belts blew up and submerged Mu, causing a lowering of the Pacific Ocean that has been mistaken for an elevation of the western coasts of America. If it is asked why the Atlantic did not flow round Cape Horn and level off the waters without withdrawing them from the shores, "In answer to this I say that the Atlantic Ocean had its own troubles to attend to during this period." The book is thus richly varied; but it is likely that its fate will be the same that Colonel Churchward laments for his friend William Niven's discovery of a civilization far back in the Tertiary era: "like all other American discoveries, it was apparently not considered in the slightest way by the scientific world" (p. 228).

Uniform with the volume under notice is a companion: "The Children of Mu," dealing with their colonies. This we must leave, as the publisher says of the first, "apparently unchallenged."

ACROSS NEW GUINEA FROM THE FLY TO THE SEPIK. By IVAN F. CHAMPION. *London: Constable & Co.* 1932. 9×5½ *inches;* xx+268 *pages; illustrations and map.* 15*s*

This book on exploration in New Guinea, and the paper by C. H. Karius on the same subject, read at the Meeting of the Royal Geographical Society on 7 January 1929 and printed in the *Journal*, vol. 174, p. 305, have together the stereoscopic effect of focussing the points of view of two observers on a common experience, and thus of bringing that experience into strong and vivid relief. The paper is the more scientific, and the book is the more popular description of two journeys, lasting seven and a half months and four months respectively, made between 4 December 1926 and 17 January 1928. In the first of these the writers, officers of the Papua Administration, attempted but failed, and in the second they succeeded, in crossing the Island of New Guinea from south to north in its wide part. In both journeys the Fly river, which flows into the Gulf of Papua on the south side of the Island, and its tributary, the Palmer, were ascended; in the first one the sources of the Palmer and of the Strickland—another tributary of the Fly—were discovered, and the two leaders working for a time independently both arrived within 7 or 8 miles of the divide between the country through which flow these rivers to the south and east, and that through which the Sepik makes its way, first of all to the west and north, and then to the east. Passes across the divide were located.

The second journey repeated many of the experiences of the first. For 512 miles it was by Government steamer up the Fly river through low forest and open grass country. Beyond this distance food storage camps at a day's distance apart were formed among low wooded hills on or near the Palmer. At about latitude 5½° S. difficult mountainous country was reached—largely limestone rock, forest covered except where laid bare by landslides. Tributary streams and occasionally the main stream had to be crossed by suspension bridges of lawyer canes or forded, or where they flowed between high vertical cliffs these had to be circumvented by arduous and wearisome detours. Crevasses and holes

in the limestone, sometimes concealed by matted vegetation, made travelling difficult. From the head of the Palmer river the southern flank of a limestone range was followed to the west as far as the village of Bolivip. Thence the party, now consisting of the two explorers accompanied by six armed police and thirty-six carriers, crossed the main divide. Made difficult by jagged rocks and waterless stages, the crossing occupied four cold and wet days at the end of November and the beginning of December. Then the gorgeous view of the Sepik Valley heartened the travellers, who proceeded on the difficult journey down it, the difficulty being enhanced by shortness in the carried food and dearth of any growing in the higher valleys. In this part of the expedition the sufferings of the author, though he does not make much of them, must have been intense, when, with an injured knee, he was carried on a stretcher through rough country. Eventually a spot on the river was reached whence rafting was possible and where food from the sago palm was plentiful. Shortly after this the Government steamer unexpectedly appeared and the journey down the Sepik, curiously enough, of the same length as the journey up the Fly (512 miles), brought the expedition to a close.

Somewhere in the book it is stated that the object of the patrols of the New Guinea Police is pacification rather than exploration, and though the journeys recorded were for the latter purpose they must have contributed materially to the former. That no shot was fired in attack or defence, although on occasions the attitude of the natives was threatening, speaks well for the control of the expedition by the two white men, and throughout the book the author's sympathetic and sensible treatment of every man he met and woman he avoided is apparent. He easily made friends with the people and attracted their friendship. As a result he came to know many of them, and though without knowledge of their language and without interpreters, he learnt much of their outlook and life. Their rude palm-covered huts and their taro gardens are described, as well as the ornaments of the men who had no clothes and the clothes of the women who had no ornaments. The race is of the Stone Age and the culture of the same character as that of the Mousterian period in Europe, with the difference that it is uninfluenced in New Guinea by large carnivora. The reader of Mr. Champion's narrative must be struck by the intelligence of the people who so readily interpreted the signs made to them and who so soon realized that they had nothing to fear from the travellers who proclaimed themselves friends. He must be struck also with what must have been the excellent conduct of the small armed police force, a picked party of loyal, intelligent, and hardworking men. Any one with experience of administration of undeveloped territories knows how difficult it is to control a native police in their dealings with the less civilized people of the country. The New Guinea police, officers and men alike, are known as a reliable and efficient force, and this book will enhance their reputation and the credit due to Sir Hubert Murray, who, as Lieutenant-Governor of Papua, has made such strenuous and successful efforts to bring them to their present high state of efficiency.

The author's style is simple and direct, and he is able to keep the attention of his readers throughout the narrative, and especially to excite their interest in its more striking incidents: the farewell of a chief, the sight of a new watershed, the capsizing of a raft, the sudden unexpected end of travels and troubles. The book is fairly well illustrated, though no doubt a more interesting collection of photographs would have been made available if many had not been spoilt by damp in the course of the first expedition. There is a satisfactory index and a good map; but in a book of this nature, where frequent reference to a large folded sheet is necessary, it is much more convenient if it is contained in a pocket or held by a

paper band at the end of the volume than if, as in the present case, it cannot be separated. Possibly the publishers will bear this in mind when preparing similar books in the future. M. N.

POLAR REGIONS

THE *MARION* EXPEDITION TO DAVIS STRAIT AND BAFFIN BAY, 1928. Scientific Results, Part 3: Arctic Ice. By EDWARD H. SMITH. (U.S. Treasury Department: Coast Guard: Bulletin No. 19.) *Washington: United States Government Printing Office* 1931. 9×6 *inches;* x+222 *pages; illustrations and maps*

In this bulletin are contained the results of the author's eight years' experience with the International Ice Patrol, and it is a very comprehensive account of the ice conditions in the North Atlantic Ocean and particularly along the West Greenland and East American coasts. The book commences with a short historical survey and a still shorter account of the *Marion* Expedition of which the writer was in command, a description so condensed indeed that the writer must be at once acquitted of one of the weaknesses of the polar scientist—the tendency to be too much obsessed with the "adventure" side of his life to the detriment of his scientific observations. The main portion of the book may be divided into three parts: accounts respectively of Arctic sea-ice, of the land-ice bordering the seas in which the *Marion* cruised, and of the icebergs derived from these glaciers, particularly with reference to their debouchment upon the main ocean traffic ways.

Of the three sections of the book, the first, that on sea-ice, is of the most general interest, for here Dr. Smith prefaces his more specialized account of the movements of the local pack with an excellent discussion of sea-ice generally, its properties, terminology, classification, and description, from which any student of the polar regions would learn much of interest.

The association of the term "ice-cap" or "polar cap" with the central sea-ice of the Arctic Ocean is perhaps unfortunate in view of the association of the term so generally in people's minds with the maximum flooding of ice-inundated lands. But the description of the ice of the Arctic seas is definitely good; the account of the effect of the local conditions upon its formation, retention, and disappearance is full and accurate, and the evidence of movement of the pack and its causes are clearly presented and of interest to more than those particularly concerned with the main objective of the Ice Patrol. Most of the striking pieces of evidence on sea-ice drift are included in the account, which is written in a way well calculated to hold the interest of the reader.

The account of the glaciation of Greenland and the neighbouring portions of the American continental islands is not of such wide scope, being written almost entirely from the point of view of iceberg production, but here and there are found facts, or second-hand accounts obtained from the local Eskimo, that are unusually intriguing. Foremost among these one must place the account of the intermittent but devastating forward movement of the Jakobshavn Glacier that must, even allowing for some exaggeration in the Eskimo description, be easily unsurpassed of its kind. "It starts slowly but rapidly gains momentum, the ice attains the incredible speed of 5 to 8 miles an hour—as fast as a fox can run, affirm the Greenlanders—to the accompaniment of a deafening roar that can be heard for miles and sometimes lasts for days." But we are not left without an explanation of this phenomena which Porsild, a well-known Danish scientist resident in Greenland, ascribes to the pent-up melt-water.

To glaciologists more familiar with the greater, but more stagnant, glaciers of the southern continent, there will be many comparisons between these and their Arctic compeers that will attract. The description of the special conditions necessary in the Arctic for the formation of floating tongues is one; the account of the peculiar conditions leading in certain years and places to the bottling-up of icebergs and the formation of semi-permanent sheets of sea-ice is another. The lesser dimensions of the ice problem in the north is well shown by the possibility of calculating—apparently with a considerable degree of accuracy—the output in icebergs from a particular district and, as is shown later in the book, of forecasting by formula the number likely to be met with along and near trade routes in a given season.

The third section of the book, that dealing with the drift of icebergs and the currents and winds that control that drift, while of considerably less interest to the glaciologist interested in ice problems in their broadest sense, is of course from the point of view of the objective of the International Ice Patrol the most important part of the work. The results achieved and the means by which they were attained are a fine justification for detailed scientific work on commercial problems such as it requires a disaster of the magnitude of the sinking of the *Titanic* to bring about. It is good to hear that the work of the patrol, the success of which on the more southern ice-infested shipping lanes is shown by the statistics in the last chapter, is likely to be reinforced by equally thorough work on the northern routes where ice is more common and casualties to ships and loss of lives still occur.

The book is well worth reading by any one seriously interested in ice and its effect on human affairs. It is thoroughly illustrated with photograph, chart, diagram, and table, and has an adequate bibliography at the end. One is loth to end on a note of criticism, but the list of *errata* at the beginning is proof that the author has been badly served by his proof reader, while, even so, all the errors of this type have not been detected; for instance, on p. 38, line 36, it is clear from the context that "icier" should be "less icy" or "more ice free." These errors detract from the pleasure of reading a very good book. R. E. P.

PHYSICAL AND BIOLOGICAL GEOGRAPHY

ERGEBNISSE DER KOSMISCHEN PHYSIK. Edited by V. CONRAD and L. WEICKMANN. Erster Band. (Gerlands Beiträge zur Geophysik. Erster Supplementband.) *Leipzig: Akademische Verlagsgesellschaft* 1931. $9\frac{1}{2}\times6$ *inches;* xii+448 *pages; illustrations and maps.* *M.*46 (*unbound* *M.*44)

This work is a supplementary volume to Gerland's Beiträge zur Geophysik. In a well-printed and illustrated volume of over four hundred pages it gives a series of six articles on the Aurora, the penetrating radiation, atmospheric ozone, the travel of sound from explosions, new methods of determining the figure of the Earth, and the dynamics of surface structures of the Earth. Each is written by an expert in the particular subject, and the result is a compendium of information not otherwise readily available, which should interest every student of geophysics.

Störmer's article on the aurora describes the structure of different types of aurora, the methods of determining the heights of aurorae, and the frequency distribution of the heights computed (showing a definite maximum frequency at about 100 km. above the surface), leading up to a mathematical discussion of the corpuscular theory of the aurora. Störmer explains the aurora as due to the motion of charged corpuscles from the sun in the electromagnetic field of the Earth, and shows that the form of the aurora can be explained by the paths

followed by the corpuscles. The problem can scarcely be regarded as completely solved since the path of an individual corpuscle which is one of a large swarm cannot be treated as identical with the path of a single corpuscle. But a complete treatment of theories and observations to date cannot fail to be of real use.

The discussion of the nature of the penetrating radiation by Kolhhörster and Tuwim begins with a description of instrumental methods for determining the variation of their intensity with atmospheric pressure, and numerous graphical representations of the results derived. There follows a mathematical theory of the absorption of the radiation, and tables give the results of a large number of series of observations of absorption in air, water, and lead. A lengthy bibliography of the rapidly growing literature of the subject completes what is at present the most authoritative discussion available.

The theory and methods of observation underlying the belief in the existence of a layer of ozone at heights of about 50 km. are described by F. W. Paul Götz. This work is associated in the first place with the names of Fabry and Buisson, whose method of observation was extended and improved by Dobson and others, including Götz. In this section Götz discusses the variation of ozone content with time of day and season, and its relation to sea-level atmospheric pressure, and gives a connected account of the results so far derived, of which the most important is the probable existence of temperatures of 300° abs. or more at heights of 50 km. The travel of sound from big explosions has shown curious anomalies, in the form of zones of silence between zones of audibility, explicable in terms of the distribution of wind and temperature with height. P. Duckert develops the necessary equations and discusses in detail a number of observations, ending with a complete bibliography of papers on the subject.

In the section which deals with the determination of the figure of the Earth, F. Hopfner develops the mathematical theory, and describes the standard methods of evaluating the form of the Earth. The present reviewer cannot lay claim to expert knowledge of this subject, but to him the section appears complete and interesting. In the final section F. M. Exner, late Director of the Austrian Meteorological Service, discusses such problems as the flow of water in streams, and of air over the Earth, the resistance to flow, the form of sand-dunes, and other surface forms. It thus covers a number of phenomena which cannot be regarded as belonging definitely to any one science but are borderland topics. The name of Exner is a guarantee of the thoroughness of the work, which is illustrated by a number of good photographs. Exner shows that the forms illustrated can be explained by the flow of water or air over the surface.

The book may be recommended as giving very valuable summaries of subjects which are growing rapidly. D. B.

MANUAL OF METEOROLOGY. Volume IV. Meteorological Calculus: Pressure and Wind. (A revised edition of Part IV, 1919.) By Sir NAPIER SHAW, with the assistance of ELAINE AUSTIN. *Cambridge: University Press* 1931. 10½×7 *inches;* xx+360+xii *pages; illustrations and maps.* 30*s*

When the 'Manual of Meteorology,' of which the fourth and final volume is now under review, was projected, the urgent need for a presentation of a coherent discussion of the relation of wind to pressure distribution led to the issue of Part IV in advance of the others, in the year 1919. During the intervening years the first three volumes have been published, and now the fourth volume reproduces in the main the original Part IV, with two new chapters at the beginning and two more at the end. The reviewer cannot but congratulate the author on his pertinacity in seeing so big a task through to the end.

The aim of the fourth volume is to present the relationship of pressure and wind. It begins by discussing the laws of atmospheric motion, dealing in turn with the recognized forces, the conservation of energy, mass, and momentum, the law of diffusion, and the nature of turbulence, ending up with a series of anemograph records, with small-scale reproductions of the synoptic charts of the same days. These records are inserted as, in a very real sense, a statement of the dynamical problem of the atmosphere; and it is undeniable that he who can interpret all the details of these charts will know a great deal about the atmosphere. The next chapter gives the standard equations of motion for an element of air. This chapter will make a limited appeal, perhaps, as algebraic manipulation is not everybody's pleasure. Here the author gives the gradient wind equation and the necessary diagrams for the computation of the geostrophic wind, but we agree with the author's view that the assumptions which have to be made in order to make the mathematical discussion of meteorological problems possible are so far reaching that the final results are often of doubtful value. Indeed, the results derived in meteorology by attempts at integrating the general equations of motion have added little to our knowledge of atmospheric processes.

In the third chapter the relation of the observed surface wind to the gradient wind is discussed in some detail, but only for inland and coastal stations. The explanation of these relationships is to be found in the next chapter, which deals with turbulence in the surface layers of the atmosphere, the treatment following the lines of G. I. Taylor's theoretical papers on the subject. The basic assumption is that an eddy is somewhat analogous to a molecule, in that it carries heat, momentum, or content of CO_2 or water vapour from one part of the fluid to another, and that the equations of transfer by eddies are similar to the equations of molecular conduction of heat. The next chapter deals in detail with gustiness of wind and the effects of turbulence on the formation of cloud. The third, fourth, and fifth chapters thus cover the field of phenomena influenced by surface turbulence, and will give the reader a very clear idea of the progress which has been made in the meteorology of the lower layers of the atmosphere. The only omission which is serious is that of the effect of contour on winds. Recent developments of soaring and gliding flight have given an added importance to the vertical motion in the lowest layers, and some discussion of observational results would have been of value. (A brief reference to these occurs at the end of Chapter VIII.)

The sixth chapter discusses the observed variation of wind with height in the troposphere and in the lower stratosphere, and here it is remarkable to note that the original papers to which reference is made are nearly all about fifteen years old, in view of the vast amount of upper air data accumulated since the war. The fault is not the author's, the fact being that very few attempts have been made to discuss statistically the rapidly accumulating observational data. The relation between vertical change of wind and the horizontal distribution of temperature is discussed in Chapter VII. This is followed by a chapter on the graphical analysis of air flow, along the lines suggested by V. Bjerknes. The possibility of interpreting depressions, and in particular secondary depressions, as discs of revolving fluid, is treated at length in two chapters, the author's final conclusion appearing to be that simple revolving fluid probably does not occur in the atmosphere.

Chapter XI is the most important of all. It treats of the kinematics of air-masses and the development of fronts in a few very lucid pages, and then goes through a whole series of theories of depressions, leaving us finally with the conviction that we do not yet in reality know the three-dimensional structure of the depression, so that any attempt to represent it by a simple diagram is a

waste of time. The reader who goes through this chapter with care will at the end be in a position to consider the problem of the cyclone or depression from a wide selection of points of view. He cannot fail to be impressed with the healthy scepticism of the author, a quality very necessary in a meteorological author. The last chapter, headed "Retrospective and Perspective," is a general summary of the whole book.

The final judgment to be passed on this fourth volume will depend in part on the purpose of the reader. If he seeks a logical development of the dynamics of the atmosphere, and of the immediate consequences of these dynamics, he may feel that the author has indulged too much a partiality for the pictorial. The book is not, in general, a suitable text-book for the beginner, unless the beginner has ample time for contemplation. But for the reader who already has some acquaintance with the dynamics of the atmosphere it cannot fail to lead to a fuller appreciation of the nature of atmospheric motions, and a more critical attitude towards meteorological theories. The eleventh chapter, in particular, will repay reading and re-reading, and will help to correct the wrong impressions of simplicity of atmospheric phenomena which so many other writers on the subject contrive to give. The book is one which every professional meteorologist will study with interest and much profit. D. B.

THE AGE OF PITHECANTHROPUS. By L. J. C. Van Es. *The Hague: Martinus Nijhoff* 1931. 10×6½ *inches;* xii+142 *pages; illustrations and maps.* 8 *gld.*

The author gives a very full account of the stratigraphy of Java, with the object of determining the position in the Tertiary sequence of the fossiliferous beds out of which Pithecanthropus was obtained. The age of these vertebrate-bearing beds has been variously assigned to Pliocene and Pleistocene. It is obvious that there must be considerable uncertainty in any attempt to correlate strata so far from the European area with the standard divisions of the Tertiary period. The author has discussed however the distribution of the marine, freshwater, and vertebrate faunas, and the consensus of the evidence furnished by these different classes of organisms indicates an early Pleistocene age. Direct correlation with the European area is possible for the Miocene period on account of the occurrence of foraminifera which have been proved to be of zonal significance. Succeeding these beds there are various fossiliferous horizons characterized by abundance of marine shelly faunas. The author applies to these the principle of the ratio of living to extinct forms, which was originally proposed by Lyell for the delimitation of the stages of the Tertiary period in Western Europe. The author rightly argues that this method can only be satisfactory if the fauna is large, and on this basis he finds a number of stages, which he attributes to the Pliocene, containing an increasing proportion of living species in the Tertiary sequence. The oldest beds attributed to the Pliocene contain 45 per cent. of living species; the later stages contain 70–80 per cent.

The vertebrate beds of Trinil, from which Pithecanthropus was obtained, overlie the beds attributed to the Pliocene, but contain only freshwater mollusca in addition to the vertebrate fauna. Although less reliable than the marine forms, the author finds from 83–87 per cent. of living forms at that horizon. The evidence furnished by the mollusca is not contradictory to that furnished by the evolutionary stages of development of the vertebrate fauna.

The memoir is accompanied by numerous maps and sections, and is not only of interest from the method of treatment adopted by the author, but is likewise a valuable contribution to the geology of the area. O. T. J.

CARTOGRAPHY

AN ACCOUNT OF THE PRIMARY TRIANGULATION OF MALAYA, together with the Secondary Chain through Kelantan and Secondary points on Penang Island. By VICTOR A. LOWINGER. [*Kuala Lumpur: Office of the Surveyor-General, F.M.S. and S.S.*] 1931. 13 × 8 *inches;* iv + 88 *pages; illustrations, triangulation diagrams, and map*

This book fulfils a double purpose. It combines a permanent record of the data of each of the primary stations in Malaya with an historical sketch showing how those data have been obtained. Of that part of the book which deals solely with the recording of data there is little to be said, save that all the requisite information is given in a form which is both excellently clear and easy of reference. The earlier portion of the book, which deals with the history of the F.M.S. Survey Department and gives the fullest details of the measurement of the bases, the instruments used and methods of observing, is of the greatest value and of absorbing interest. These few pages should certainly be put in the hands of all young surveyors going out to the Colonies, not only for their instructional value, but also because they cannot fail to implant deeply in the mind of the reader a lasting respect for all such triangulation, when it is realized at what a cost of money and human endeavour the results have been obtained.

Those who have had some experience of surveying conditions in Malaya will realize fully the difficulties and hardships which have been overcome, hardships only hinted at by a single statement, with reference to the measurement of one of the bases, that "the observers and men . . . found it difficult to remain steady, for the leeches could be numbered by the hundred to the square foot"!

In the preface the first of the two main factors which influenced the decision to observe a chain of first-order triangulation is stated to be "The possibility of a junction with Siam on the North and the Dutch East Indies work in the South." It is stated elsewhere in the book that the junction with Siam will shortly be made. It is very much to be hoped that this will prove but the first step in a series of connections which will ultimately link the Survey of India's work in Burma, through Siam and the Malay States, to the Dutch triangulation in Sumatra, and finally, dare one hope, to Australia through the islands of the Eastern Archipelago. One wonders however whether the "Everest" figure of the Earth deserves so wide an expansion or whether some suitable spheroid rounded off to suit the imperfection of our knowledge should not be employed; with due apologies to the meeting of the International Geodetic and Geophysical Union at Madrid. J. C. T. W.

ECONOMIC AND HISTORICAL GEOGRAPHY

THE COURT-MARTIAL OF THE *BOUNTY* MUTINEERS. Edited by OWEN RUTTER. *Edinburgh and London: William Hodge & Co.* 1931. 8½ × 5½ *inches;* x + 202 *pages; illustrations.* 10*s* 6*d*

Although, as Mr. Rutter frankly admits in his introduction, the mutiny of the *Bounty* bears no peculiar importance in naval history, the circumstances have aroused considerable interest and curiosity ever since the morning of 28 April 1789, when Lieutenant Bligh and eighteen of the crew were hustled into an open boat in Mid-Pacific, and left to almost certain destruction. The incident has become famous by reason of its sequel. In the first place Bligh brought the boat after a six weeks' voyage to Timor, and so achieved a remarkable feat of navigation. Secondly, the subsequent history of the mutineers unfolded itself like a tale from the author of 'Treasure Island.' And thirdly, controversy arose on the

respective blame-worthiness of the two protagonists, Bligh the Commander and Fletcher Christian the leader of the mutiny.

In 1787 the *Bounty*, after having been specially fitted out by the Admiralty, was sent under Bligh to secure a collection of bread-fruit plants from Tahiti, which were to be transported to the West Indies as an additional source of food for the negroes. Bligh was already recognized by the authorities as a very efficient officer, but he was also known to naval ratings as a ruthless disciplinarian with a fiery temper. Unfortunately for the enterprise, one of the Master's mates, Fletcher Christian, who was of Manx origin, was possessed of a sensitive highly-strung temperament, which reacted to harsh treatment in the worse possible way, and which reduced him to a state bordering on insanity. During the course of the three months' outward voyage Bligh's tyrannical methods had aroused general hostility. But to a man of Christian's temperament the intolerable daily contact with such a personality within the narrow confines of a ship's company became, to use his own description, "hell." Indeed, the chief interest of the present volume lies in the detailed psychological study which it presents of the clash of two incompatible temperaments. One incident may be cited as typical. Discovering that some of the coconuts which he had purchased from the natives had been stolen from the deck, Bligh, in the most outrageous terms, accused Christian of having stolen them. Soon afterwards, the incident forgotten, he invited the latter to dine with him; but Christian, nursing his rage and humiliation, excused himself on pretence of illness.

After the inevitable explosion had occurred, and Bligh with his party had been set adrift, Christian took the *Bounty* back to Tahiti, where fourteen of the mutineers elected to remain. The rest, with six native men and twelve women, sailed away to settle under Christian in lonely Pitcairn Island. Their leader seems to have died there some time later, and "drink and the devil did for the rest" of the white men—all save Young, who died in 1800, and John Smith (or Adams, as he renamed himself), who, turning religious, became the founder of a prosperous and well-ordered community. The mutineers who had remained in Tahiti were found by H.M.S. *Pandora*, which had been sent out in search of them; and the court-martial which was held on those who survived the wreck of that vessel is the chief concern of the present volume.

In addition to printing the actual minutes of the court, Mr. Rutter has been at pains to incorporate in his introduction Bligh's despatches from the Admiralty Papers in the Public Record Office written before the mutiny, as well as his own official report of that event, none of which has been previously published. This introduction strikes an admirable balance in depicting the qualities of the central figures of the story. As a result of the present work and Mr. Rawson's recent biography, 'Bligh of the *Bounty*,' substantial justice has now been done to all concerned. Mr. Rutter's volume is not of great importance for the geographer or the historian, but the specialist as well as the general reader can hardly fail to add to his knowledge of human nature in perusing it. V. T. H.

A HISTORY OF GEOGRAPHICAL DISCOVERY AND EXPLORATION. By J. N. L. Baker. (Harrap's New Geographical Series. General Editor: R. N. Rudmose Brown.) *London: George G. Harrap & Co.* 1931. 8½×5½ *inches; 544 pages; maps. 12s 6d*

Previous to the publication of this work there was no book in English which dealt with the entire history of exploration in any detail. The need for such a comprehensive work has indeed long been felt, but the amount of study and research necessary is no doubt the reason why the gap has only now been filled. Mr. Baker is therefore to be congratulated upon the industry and determination

which have enabled him to accomplish with such success this heavy task. Many epochs have been covered in great detail by other writers, but the nineteenth century is an exception, and Mr. Baker has therefore devoted more than half his space to it. Even this account might well be amplified, perhaps by him at some future date. He has coped successfully with the almost unavoidable tendency, in a work of this scope, to fall into a mere list of names and dates, and he shows himself thoroughly acquainted with the literature of the subject. The very full index of fifty pages makes it a most useful work of reference. The character of the work prevents much display of originality of treatment or material, but it is certainly something more than a "catalogue," as he modestly refers to it in the preface. It is generously illustrated by fifty sketch-maps, to show routes alone, for which the authorities consulted are given. These might however have been given lines of position and scales. Considering the work that has gone to its production, the price at which it is issued is remarkably moderate.

It is impossible to enter into a detailed discussion of a book which begins with the Minoans and includes a reference to the recent crossing of the Rub' al Khali by Mr. Bertram Thomas. Wherever tested, the details have proved accurate, though occasionally statements might have been worded more clearly. Many of the travellers are reported in their own words, the extracts being carefully selected to illustrate contemporary ideas of geographical phenomena and topography. The earlier chapters are written from a "Mediterranean" view-point, which rather minimizes the work, for example, of the Chinese, in establishing contact across Asia. Later, Marco Polo's influence is depreciated, for his account undoubtedly encouraged Columbus. Dealing with the latter, Mr. Baker wisely avoids controversy, concluding that "there does not seem to be anything peculiarly fatal to the conventional ideas except Columbus and his biographers."

The concluding chapter sets out clearly the present position of exploration, giving due credit to modern travellers, and analyses the motives which have prompted the constant journeyings narrated earlier. Some reference to the development in technique might have fittingly been included here.

As a text-book for advanced students, no less than as a work of general reference, it is likely to take an assured place in the literature of the subject. It should encourage students to turn for further study to the accounts of the explorers themselves, and for this the bibliographies will be helpful. Mr. Baker's pages also ensure that the work of each explorer is seen in true perspective. The whole book is a well-executed record of a remarkable phase of human activity well epitomized by the quotation from Saint-Martin with which it closes—"une face entière de l'histoire de l'humanité." G. R. C.

LONDON IN MITTELALTER. By KURT KNOLL. *Wien u. Leipzig: Wilhelm Braumüller* 1932. 9½×6 *inches;* vi+220 *pages; diagrams and maps. M.*7.50

While working on cultural and colonial problems, and on England and her colonial problems in particular, the author of this monograph found that the City of London forced itself persistently into the forefront of his studies. This decided him to treat the city as the focus of British life and empire, and this is the first instalment of that study. He has acquainted himself with a great mass of literature, English and foreign, and presents a clear and readable digest. Apart from the introductory chapter—a geographical sketch of its position—the arrangement is strictly chronological, which is to some extent a disadvantage, as there are several subjects which would be better treated separately—*e.g.* the growth of the city, its municipal rights, foreigners and foreign trade. These tend to be rather obscured by details of general English history. He does however bring out the predominance of London from early times, especially as the intermediary between England and the wider world.

This predominance owed much to geographical position, and particularly to the river Thames, and Herr Knoll is right to concentrate upon the river as the key to the city's development. He might have given a little more consideration to the surrounding region, and to land routes and possible rivals, such as Winchester.

The main theme is historical, and follows commonly accepted lines. He inclines to the belief in a pre-Roman London, and perhaps rather too strongly to the sweepingly destructive character of the Saxon invasions. The present study ends with the reign of Richard III. His derivation of "Domesday" from "Domus Dei" (the lands of the Church) seems far fetched. There does not seem to be ground for doubting the existence of 126 churches in mediaeval London. A better map might have been chosen to accompany this careful study. G. R. C.

LES CARACTÈRES ORIGINAUX DE L'HISTOIRE RURALE FRANçaise. By MARC BLOCH. (Instituttet for Sammenlignende Kulturforskning. Serie B: Skrifter. XIX.) *Oslo: H. Aschehoug & Co.; London: Williams and Norgate* 1931. $9\frac{1}{2} \times 7\frac{1}{2}$ *inches;* xviii + 262 *pages; maps*

This is no. 19 in series B of the valuable publications by means of which the Instituttet for Sammenlignende Kulturforskning contributes in so important a fashion to the study of mankind. The series naturally occupies itself in considerable measure with studies of Norway, but takes opportunities to invite scholars of other lands to contribute. This *Journal* has noticed a number of reports of the Commission de l'Habitat Rural organized by the International Geographical Congress, and the present study is a valuable complement from an entirely independent point of view to the discussions which that commission has developed. It might have helped both the Commission and M. Bloch had they been in closer touch. The scope of this work is indicated by chapters on the main stages in occupation of the land, agricultural life, the seigneuries down to the crisis of the later Middle Ages, the transformation from the Renaissance to the French Revolution, social groupings, the trend towards individualism, and the present in the light of the past. The plates are largely field-maps.

M. Bloch does not attempt to enter into the difficult and necessarily speculative field of rural prehistory, but he sees clearly that one finds traces of the results of the use on the one hand of the old *aratrum* (araire: *Ger.* erling; *Slav* oralo) at home in the Mediterranean and the larger plough or *charrue* worked by ox-teams, a development probably in Germanic lands. The older implement seems to give smaller fields with shorter strips; the later one is the parent of the long strip of the champaign lands and, unlike its elder sister, has utterly diverse names in different groups of languages. For M. Bloch the fundamental rotation is the two-field system, the three-field scheme being, as every one agrees, an improvement, of a later date not yet very well fixed, invented probably in Germanic lands. The pre-existence of strips and old collectivist field systems in regions such as south Brittany and the Channel Islands, now typical areas of enclosed compact farms, was shown in papers contributed especially by Miss Harris to the Commission de l'Habitat Rural. Both her work and that of M. Bloch make it clear that there is need to amplify in important ways Meitzen's famous pioneer study; one can but wish that he were still living to combine his massive knowledge with this work of M. Bloch and the pre-historic studies to which Gordon Childe is contributing so notably in order to make a new and better picture that should also deal with the demographic question involved, a question of primary interest to geographers but one which M. Bloch places in large measure outside his field, though he naturally makes many valuable references to it. The author emphasizes, as Sidney Herbert did in England ("The Fall of

Feudalism in France') some years ago, the great importance of the agrarian aspect of the French Revolution, and is deeply imbued with the idea of the continuity of rural life in France from remote times to the present day as well as with a feeling that it is going to persist in the future without fundamental change.

H. J. F.

A SHORT HISTORY OF BRITISH EXPANSION. By JAMES A. WILLIAMSON. (Second Edition.) Two vols. Vol. I, The Old Colonial Empire, xx+470 *pages*. Vol. II, The Modern Empire and Commonwealth, xvi+316 *pages*. *London: Macmillan & Co.* 1930. 9×5½ *inches; maps.* 15*s each*

This widely circulated short history of the British Empire which appeared in one volume in 1922 and was reprinted in 1927, is here considerably revised and enlarged. The portion of the work dealing with the history of the Empire down to the loss of the American colonies remains much as it was in the earlier edition, but with certain corrections, particularly in the account of the West Indian colonies in the seventeenth century. These have been rendered necessary by the results of the considerable amount of research concerning the subject that has recently appeared, especially from the labours of Dr. Williamson himself. As the first volume now stands, it forms, perhaps, the most accurate and compendious history of the expansion of the British peoples oversea from the fifteenth to the eighteenth century both in trade and settlement. It also forms a most useful guide for British readers to the history of what are now the United States during their colonial period. Its closely packed pages are filled with a cool and scholarly account of that history which is far more reliable and less biased than that contained in the usual handbook of American History.

For the period since 1783 the work has been entirely rewritten, and the second volume is, in fact, practically a new book. As the author explains in his preface, many things have become clear that ten years ago were undefined in the history of the British Empire, and the study of the Empire and Commonwealth has been very greatly extended and organized. In the past the comparatively slight and unsystematic work done was confined either to narrative or to the study of certain aspects of the constitutional growth of the self-governing dominions. The vast changes brought about by the progress of means of communication and by the opening-up of new sources of raw materials were mostly neglected. Dr. Williamson does much to remedy this defect of treatment and the book is probably the first compendious account of the Empire, especially since 1870, which allots due space to historical developments in spheres other than that of government. It will be of great value both to the student and to the general reader, for it treats the problem whole and recognizes the fundamental unity of the Empire's growth among all its bewildering diversities. The history of the colonies of the Dependent Empire in the modern period, which is almost entirely neglected in the usual text-book, is here accorded a considerable place, and this is one of the most satisfactory features of a book that deserves recognition as perhaps the best and most comprehensive handbook in this increasingly studied field.

A. P. N.

HISTORY OF PALESTINE AND SYRIA, TO THE MACEDONIAN Conquest. By A. T. OLMSTEAD. *New York—London: Charles Scribner's Sons* 1931; 9½×6½ *inches;* xxxii+664 *pages; illustrations, maps, and plans.* 30*s*

The author of this volume takes us the long journey from Palaeolithic Man to the writer of the Book of Job, and deals chiefly with an area extending from the Negeb and the north-eastern frontier of Egypt, northward for 500 miles; a narrow strip never more than 100 miles wide, that is, from east to west, but including that most important coastal area, Palestine, Lebanon, Hollow Syria,

the whole course of the Orontes, and the ancient towns of Damascus, Tyre, Sidon, Gebal, Arvad, Kadesh, Hamath, Aleppo, Carchemish, Samal, and Marqasi.

The writer leads us through the Early Bronze Age to the period of the Egyptian invasions of Syria and Palestine, and to that of the middle of the fifteenth century B.C., when these countries came under the political control of Egypt. He gives us a connected account of the political and military moves of that century and of the succeeding one, illustrated largely by the Tell el-Amarna Tablets and the recent discoveries at Beth Shan. He touches on the problem of the Exodus, noting that Israel is mentioned as already in Canaan in the reign of Merneptah (1225–1215), so that Merneptah cannot be the Pharaoh of the Exodus. For the period of the Judges the student will be well advised to compare Professor Olmstead's treatment with that of Professor John Garstang, in the important book published last year by the latter, 'Joshua Judges,' a book of great value and interest.

We then have chapters on Saul, David's Empire, Solomon in All His Glory, The Revolt of Israel, the Repulse of Ashur. With regard to Omri the author remarks, "His dynasty was the greatest in Israel's checkered history, and gave his kingdom international rank among the greatest of the second-rank powers; long after his dynasty perished, foreigners called Israel the House of Omri." The Moabite Stone is not itself discussed, though a plate is given of it and a translation of its inscription is incorporated in the text. This system of not mentioning the original authorities in the text, especially such a striking and picturesque authority as the Moabite Stone, though it makes the narrative flow easily, takes away from some of the interest, and renders the history less easy to picture and more difficult to remember.

The remaining chapters deal with such subjects as Assyria's Return, Israel's Fall, Josiah's Reform, The Fall of Jerusalem, The Prophets, Those from the Land of Sinim (Syene on the Nile)—a curious glimpse into the life of a Jewish community in Egypt in the fifth century B.C.—with some final remarks on the development of Judaism under Persian rule, and the times of the writers of Ecclesiastes, Job, and Jonah. The book displays a great wealth of learning. Considering the immense difficulty of the task of compressing so much vital history into the compass of a single volume, it succeeds well in presenting a series of composite pictures of the reactions of Palestine and Syria to the pressure of the empires of Egypt and Assyria, of the struggles of races and customs and the development of religious ideas. It is a very attractive book in which account is taken of the latest teachings of field archaeology. But a geographer may be allowed to grumble at the poor character of the maps, in black, on one sheet, at the end of the volume. These maps are really almost valueless for illustrating the topography which largely conditioned the movements of the races, armies, and individuals described. C. F. C.

THE DISASTER OF DARIEN: The Story of the Scots Settlement and the Causes of its Failure, 1699–1701. By FRANCIS RUSSELL HART. *London: Constable & Co.* [1930]. 9×6 *inches;* xii+434 *pages; illustrations and facsimile maps.* 18*s*

The tragic story of the Darien Company from its foundation by William Paterson in 1693 to its practical dissolution in 1707 has provided a subject for many books, but it can hardly yet be claimed that it is exhausted, and we still await a comprehensive study that will place the episode in its true relation to the movements of the time, international and domestic. There can be no doubt that it played an important part in the struggle for power and trade in the Caribbean in the

momentous years that preceded the War of the Spanish Succession, and this has never yet been fully treated, though it was at least as significant as the part played by the Darien affair in British domestic politics. This side of the story is hardly touched upon in Mr. Hart's short study, the chief concern of which is to give a narrative of the two attempts at Scottish colonization that were made between 1699 and 1701. The account of the first voyage is almost wholly drawn from a single source, the Journal of one of those who took part in it, but for the second attempt a wider range of authorities has been consulted and a composite narrative built up. Unfortunately, only a very small space is given to an interpretation of what occurred, but the work makes a useful addition to the subject by reason of the Appendix, which fills more than half of the book. In it there is collected a large mass of contemporary documentary evidence, a large part of which was previously not readily accessible. This includes many important Spanish documents from the Archives of the Indies, which are given in translation. The correspondence of the governors of the Caribbee Islands, which contains constant references to the Darien scheme and the dispersal of the refugee colonists which added a valuable Scottish element to the population of the islands, has hardly been consulted. There are some reproductions of contemporary maps and some interesting illustrations, but unfortunately the value of the work as a study is diminished by the absence of any bibliography. This is peculiarly necessary in a subject concerning which there has been so much controversy, and the absence of it almost confines the usefulness of the work to its collection of documentary material. This makes a welcome addition to the literature of the subject. A. P. N.

EUROPE AND CHINA: A Survey of their Relations from the Earliest Times to 1800. By G. F. HUDSON. *London: E. Arnold & Co.* 1931. 9×6 *inches;* 336 *pages; sketch-maps.* 15*s*

The majority of works upon the relations between China and the West have concentrated upon the nineteenth and twentieth centuries, when Western influences were shaping China's destiny for good or evil. It is one of the merits of Mr. Hudson's book that it restores the balance, and describes in detail the lengthy period in which, on the whole, China exerted greater influence upon Europe than she received in return. In his opening chapters he traces the first stage in this development when the initiative in establishing relations with the Hellenic states of south-west Asia was definitely undertaken by the Chinese, typified by the arrival of a Chinese embassy in Baghdad in A.D. 97. The growth of the trade in silk and other oriental luxuries which followed exercised a weighty effect upon the economy of the Roman Empire, though little of the gold exchanged appears actually to have reached China.

The expansion of the Western European nations, dating from the later Middle Ages, is ascribed by Mr. Hudson to the lure of the wealth of the Orient. He also assigns a leading role to the Genoese. It was they, alone of Mediterranean peoples, who were accustomed to sail beyond their inland sea, and they who evolved the plan of reaching the east by the "way round Africa," a plan ultimately passed on for execution to the Portuguese. It is perhaps pressing the point too far to see in China the final goal of the seekers after the spice trade, as he recognizes. Certainly the title of his work does not promise a history of the sea route round Africa, or, still less, of Columbus's aims and Spanish expansion westwards. Surely, on the same grounds, the efforts to find a passage by the north-east might also have been discussed? However, since he does discuss Columbus, it may be noted that he puts forward a common-sense explanation, based upon a modification of the theories of the late Cecil Jane. Other points raised are perhaps more debatable.

Having established contact between China and the Europeans, Mr. Hudson proceeds to what, to the general reader, will probably be the most informative section of his book. The opposing characteristics of each civilization are well brought out, and reasons given for the ascendancy of China in the cultural exchange. The chapter on the Rococo style demonstrates the extent of Chinese influence on European art in the eighteenth century, especially in France, an influence which, though not enduring, spread a knowledge of China which enabled her social and political ideas, introduced by the Jesuit missionaries and adopted by the Physiocrats, to gain a footing. Voltaire and the "enlightened despots" are shown to have owed much to Chinese thought. Mr. Hudson might well have developed this thesis, at the expense of the earlier exploratory chapters, which deal with a well-worn subject. It is the real subject of this accomplished work. His argument throughout is presented in forceful and clear prose, is well ordered, and holds the reader's interest to the end, as each facet is displayed, of which a few alone have been noted above. G. R. C.

HISTOIRE DE LA NATION EGYPTIENNE. Tome I. Introduction Générale; par GABRIEL HANOTAUX. La Géographie de l'Egypte à travers les âges; par CHARLES DE LA RONCIÈRE. *Paris: Société de l'Histoire Nationale—Librairie Plon* 1931. $11\frac{1}{2} \times 9\frac{1}{2}$ *inches;* xciv+428 *pages; illustrations and maps*

This is the first of a series of seven volumes dealing with the history of the people of Egypt from prehistoric times to the present day, which is being prepared under the general editorship of M. Hanotaux. It owes its inception to H.M. King Fuad, whose catholic promotion of all literary and scientific activity in connection with his country is well known. The work is clearly intended for the general reader and makes no pretension of adding to the foundations of our knowledge. It is well printed and turned out, a peculiarly pleasing feature being the generous supply of excellent illustrations in black and white, which greatly add to the clarity and attractiveness of the text. There are also a dozen good reproductions in colour of various paintings and tapestries.

The main theme of the Introduction is the dominant influence upon Egypt's long history of her geographical position. The alluvial valleys of the Nile and of the Mesopotamian rivers provided very similar cradles for our civilization; but geography exercised a widely differing control on the subsequent destinies of the peoples nurtured therein. Egypt, nourished by her mysterious river, but severed by great deserts from Asia and Africa, of which she forms territorially part, occupied an island position at the meeting-place of the three continents and the two principal seaways of the ancient world. At all progressive periods from the time of the Lagidae onwards she has looked across the sea to Europe rather than across the deserts to Asia and Africa. Muhammad Ali, the founder of modern Egypt, was also a Macedonian. M. Hanotaux further adopts the cutting of the Suez Canal as the opening of the world epoch in man's history, which is being produced by communications and intercourse of an increasingly international character. The construction of the canal finally sealed Egypt's inseparable connection with world communications and world policies, and her necessary association thenceforth with the maritime and progressive powers.

The theme is not a new one; but it is freshly emphasized and developed by M. Hanotaux. If it can be kept in mind throughout the six succeeding volumes as the controlling and unifying thread in Egypt's long history, the work should prove unusually interesting and instructive.

M. de la Roncière has the difficult task of briefly reviewing the geography of Egypt and the Nile Basin in its widest manifestations from its geological beginnings till the present day. The more purely geographical aspects are considered

under the headings of Physical Geography, the Libyan Desert, the Arabian Desert, Sinai, and the sources of the Nile. He is well informed about recent desert work and presents a clear picture. The fuller modern recognition of the inter-relation of geography and history is illustrated by the titles of his two most important sections—"Géographie historique" and "Géographie humaine"—which occupy more space than the other five. They provide an excellent epitome from the geographical standpoint of a development which will be treated in much fuller detail by the historians subsequently. It is also probably desired to make each volume of the series as self-contained as possible.

Errors are unavoidable in any treatment of so wide a subject. Some that have been noted should be mentioned. There is no justification for the suggestion (p. 20) that the six rock-impeded river reaches, termed the Nile Cataracts, may act as life-giving storage reservoirs. In their natural state they are merely useless obstructions to the passage alike of boats and of water. On the other hand a real and valuable natural reservoir is formed by the annual banking up of the White Nile by the Blue Nile in flood at their junction. This suggested the projected Gebel Awlia Dam. The great lakes also exercise a useful regulating effect, although wastefully. The great swamps, which have also been claimed to be natural reservoirs, have been definitely shown to be merely a source of seriously injurious loss. The Khedivial flag ceased long ago to fly at Suakim (p. 264). The *feddau* and the *ardeb* no doubt varied widely at one time (p. 277). Originally the former, as in other Arabic-speaking countries and like some of our own measures initially, was a unit of farm work, and not of area. But a uniform *feddau* (=4800·833 square metres or 1·038 acres) was legalized and brought into use throughout Egypt during the first cadastral survey of the country, which was completed in 1906. The *ardeb* was standardized (=198 litres) under a general weights and measures law in 1914.

A note on the modern cartography of Egypt is appended which provides a useful record, more particularly of work done at the time of, or following, the French expedition to Egypt. The author pays a generous and well-deserved tribute to the Atlas prepared by the Survey of Egypt for the Geographical Congress in 1928, and cites their regular map series. It would have been a useful service to cartography in its fullest sense if he could have found a little more space to explain to his readers that the results graphically summarized in these publications are derived from systematic and detailed trigonometrical, cadastral, topographical, and geological survey, and of meteorological and hydrographical study of the Nile Basin, conducted throughout the previous thirty years. It is too little appreciated by the general public that the real value of the beautiful pictures of the land surface that reach them in the form of maps are dependent upon the scientific bases of the work presented, which do not appear. E. M. D.

GENERAL

THE BOOK OF THE SAILING-SHIP. By STANLEY ROGERS. *London: George G. Harrap & Co.* 1931. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches; 282 pages; illustrations.* 7*s* 6*d*

This book is written for boys, and should prove invaluable to any youngster who enjoys sea-tales and wants to understand fully the adventures of which he is reading, the difficulties and dangers which his heroes have had to overcome, and the conditions under which sailors lived in the past. It will also assist many a grown-up landsman with his difficulties in comprehending those strange maritime terms which help nautical writers to produce the impression of sea, wind, and storm. But it must not be treated as a book of reference, for Mr. Stanley Rogers has covered so wide a subject as to render some mistakes unavoidable.

The chapters which deal with the last days of the sailing-ship are on the whole admirable, but when the author ventures into the past, his guidance is not so sure. For instance, he repeats the old error that a catamaran is a form of outrigger canoe, whereas the term really applies to the log-rafts of the Madras coast. Similarly, while the illustration of an early cannon shows a muzzle-loader, all the early guns fitted to flat beds, as in the drawing, were actually breech-loaders, and muzzle-loaders did not come in till later, when they had proper gun-carriages.

A much more serious error is the misuse of the term " galleon " and a misunderstanding of the significance of that term. In England the word came into use in the reign of Elizabeth, and had certainly disappeared by the time of the Commonwealth; yet the author uses it to cover our big ships from the reign of Henry VIII right up to that of Queen Anne. He has not realized that an English galleon was a development from the carrack, in which a bow, modelled somewhat after the beak of the galley, had been substituted for the high overhanging bow of the carrack. It is also an error to speak of Elizabethan galleons as especially bluff-bowed, for they were, in fact, very much finer forward than were the big ships of the later Stuart sovereigns; an apparently retrograde alteration rendered necessary by the very much heavier armaments which, before the close of the seventeenth century, men-of-war were expected to carry. It is also to be regretted that Mr. Stanley Rogers repeats the common mistake of the early nineteenth century in referring to the gilded carving with which the ships of Tudor times were said to be adorned. Recent investigation has shown that the ships of both Henry VIII and of Elizabeth were decorated with brightly contrasting colours, arranged in geometrical or semi-geometrical patterns, and with little carving and no gilding except for the figurehead, and that it was not until the accession of James I that we find the introduction of the very elaborate and richly gilded carving, on the broadsides as well as on both bow and stern, which distinguish the great ships of the Stuarts from those of every other age.

The numerous line illustrations in the text are of much value in helping the reader to understand the subject, but it is at least doubtful whether the somewhat crude colour-plates serve an equally useful purpose. The book as a whole however is well calculated to stimulate that interest in sailing-ships which in British boys, and in men too, neither steamships nor flying machines have been able to kill, while on the human side it contains many tales of gallantry in the face of stupendous difficulties. Of these one of the most recent, and certainly not the least impressive, is that of Shackleton's voyage in a 20-foot whale-boat from Elephant Island to South Georgia, more than 700 miles across the Antarctic Ocean, in order to bring help to his shipwrecked crew. G. S. L. C.

THE MONTHLY RECORD

SEVENTY-FIFTH ANNIVERSARY OF THE GEOGRAPHICAL SOCIETY OF VIENNA

On December 15 last the seventy-fifth anniversary of the Geographical Society of Vienna was celebrated at an evening session, the programme of which is described in the *Mitteilungen* of the Society, vol. 74 (1931), pp. 265–75. The President, Professor Eugen Oberhummer, in an address reviewing its activities, dwelt upon its influence in promoting geographical education, in co-operation with the University, and through organized excursions. He also referred to the support given to expeditions, notably those of the *Novara* and of Weyprecht and Payer. To mark the occasion, the Society had appointed four Honorary Members, one of whom was Sir Francis Younghusband. Professor H. Hassinger then spoke upon the progress and future of geographical studies in Austria. He emphasized the value of up-to-date topographical maps for all branches of the study, and described the present position: one-twelfth of the country has been re-surveyed for the new 1 : 50,000 map, but the fraction of published sheets is naturally considerably less. The cadastral map is further in arrears, though the new survey of the Burgenland communities is in progress. As Austria possesses a survey on the scale of 1 : 28,800 dating from the second half of the eighteenth century, and on the scale 1 : 2880 from the early nineteenth century, a new survey, for historical reasons alone, would be of great value. Professor Hassinger then described the work which was still to be done in investigating the geology, geomorphology, and economic and human geography of Austria.

It is evident, despite the difficult times through which the country is passing, that the activities of the Society are being well maintained.

THE GEOGRAPHICAL SOCIETY OF BELGRADE

Recent publications of this Society, which was founded by the late Professor Jovan Cvijić, include Tome XVII (1931) of the *Bulletin*, containing a number of original articles as well as reviews, geographical notes, etc.; two fascicules (nos. 10 and 11) of the series of special publications, consisting of collections of articles on particular topics; five fascicules (nos. 1 to 5) of an Atlas of Land-forms; two maps of the whole of Yugoslavia on a scale of 1/1,200,000, the one a zoogeographical and the other a soil map, and a collection of reproductions of old maps of the Balkans. The letterpress throughout this extensive output is in Serbian, but the authors have added abstracts in French or German, while the plates of the Atlas are annotated in French as well as in Serbian, and the needs of those unacquainted with the latter language are also provided for in the case of the maps.

In the main the authors represented in these varied publications tend to follow up the lines of research initiated by the founder, showing that his influence has been abiding. Thus much space is devoted to the origin and interpretation of land-forms, as well as to the characters and distribution of rural habitations and urban settlements. The soil map, which has been prepared by Professor A. I. Stebutt, is based on the classification first laid down by Russian investigators, and forms an excellent foundation for the study of the human geography of the country. It shows a great central area, with an extension to the north-west, within which the soils are for the most part of the undeveloped mountain "skeletal" type. In other words, there is much bare rock, and little true soil save in the valleys and over the high mountain pastures, which are shown by special stipple. As against this central block four peripheral zones can be recognized.

To the north-east, extending southwards only to the Sava–Danube line, chernosems are developed, intermixed with saline patches, blown sand, and some brown earths. To the south of this area brown earths predominate, while the lower grounds of the north-west are mainly clothed with podsols. The western littoral is characterized by considerable patches of red earth (*terra rossa*), but is mainly of the "skeletal" type, that is, consists largely of bare limestone rocks with limited and localized deposits of red earth and alluvium.

This karstic zone is of course of surpassing interest to the geographer, so that it is not surprising that many of the Atlas plates and not a few of the articles should be devoted to its various aspects. Fascicules 1 and 2 of the Atlas are entitled respectively the Dinaric Karst and the Dinaric Littoral. In the latter a view of the Bocche of Kotor, which brings out the contrast between the bare and steep limestone slopes and the lowlying flysch at their base, richly clothed with vegetation, may be noted especially as affording a key to much of the human geography. Thus an article in the *Bulletin* by Josip Roglić deals with the littoral of Makarska, which lies between Split and Dubrovnik and is characterized by the development of a belt of flysch at the base of a bare limestone plateau. It is pointed out that here the original settlements tended to lie at the junction between limestone and flysch, giving a double resource in agriculture and stock-rearing, for sheep and goats can find a living on the scanty vegetation of the limestone But this zone is tending to be abandoned in favour of that which follows the littoral highway or the coastal belt proper. In the former stock-rearing becomes only a minor resource and the olive is the chief object of cultivation; in the latter seafaring is added to the cultivation of the land as a source of livelihood. An article by Dr. H. Renier on settlements in Bosnia and Hercegovina, again, emphasizes the fact that in the interior these tend to be placed on the margins of the polyes and dolines, to avoid the sterilizing of any of the limited tracts of fertile land. Other topics dealt with include a detailed survey of the climate of Hvar (Lesina) as influenced by the prevailing winds. The articles are however of a varied nature, and their value is much increased by the ample illustration afforded by the Atlas.

One section of the Atlas calls for special comment, as bearing witness to the enterprise of the Society. Fascicule 6 is the first instalment of a collection of reproductions of early maps of the Yugoslav countries, and in the eight items now given we have a varied selection from the early period of crude efforts at mapping, ranging from Ptolemy to Barents (1595), and including sections of the Peutinger Tafel, a "Beatus" map, the map of Idrisi, and one or two Portolan charts. All are more or less familiar to students, for, failing access to the originals, they have been taken from already existing reproductions, and as the editor, Dr. Sindik, allows, the results are not entirely satisfactory. Still it is of interest to have the maps assembled for comparison and the collection may gain in interest when it comes down to later times. There is no explanatory text so far. M. I. N.

PORTRAIT OF CHARLES ENDERBY

We are indebted to Dr. Hugh Robert Mill for an enlargement from the photograph of Charles Enderby shown by him in the discussion on Sir Douglas Mawson's paper on March 7. The original *carte-de-visite* photograph was lent for the purpose of enlargement by Enderby's grand-niece, Miss Gordon, a cousin of General Gordon.

Charles Enderby, an original Fellow of the Society and for many years a Member of its Council, died in 1878. He was for a time the chief partner in the old firm of Enderby Brothers, of London, shipowners, whose ships carried the first cargo of taxed tea to Boston in 1776, and who carried on a sealing trade to

the Antarctic from a New England port. One of their vessels discovered the Auckland Island in 1808, and Charles Enderby established a chartered British Whaling Company there in 1849. The Antarctic discoveries of Biscoe in 1830–32 and of Balleny in 1839 were made in the Enderbys' ships.

RESEARCH IN EASTERN SIBERIAN WATERS

The Russian ice-breaker *Litke* was sent in the summer of 1929 from Vladivostok to Wrangel Island to take supplies and fresh personnel to the colony there, and advantage was taken of this opportunity to carry out oceanographical research during the voyage, various scientific men taking part in the work. The detailed observations are recorded in Russian in Fasc. 13 of the series issued by the Hydrological Institute under the title 'Explorations des Mers d'U.R.S.S.,' but a summary in German permits the main results to be grasped by those unacquainted with Russian. The *Litke* left Vladivostok on July 14 and found the first ice 22 miles north-north-east of Cape Serdze-Kamen. Open water continued however to about 71° N. 175° W., and the ship again approached the edge of the ice only on August 7. South of Herald Island an ice-drift was experienced from August 8 to 25, some open spaces being then found to the east. A course to the north of Herald Island brought the ship to Wrangel Island on the 29th, the return voyage being begun on September 6. During the voyage hydrological observations were made at forty-three stations, and some hundreds of temperature measurements and samples of water were taken, while four hydrological sections in different directions across the waters navigated were worked out. The existence of warm and cold currents in the East Siberian Sea was confirmed, one of the latter being found south of Cape Deshnev. A gyratory movement of the water was observed both in the centre of the East Siberian Sea and to the south of Herald Island. A strong aeration of the water was noticed at all levels, while alkalinity was concentrated in the surface ice, the content of other layers being normal. The currents observed seem rather to remain constant than to vary with the season.

LAST SPANISH EXPEDITION ON NORTH-WEST AMERICAN COAST, 1793

The Nootka Sound controversy gave a last impetus to the Spanish exploration of the north-west coast of North America. To anticipate further English settlement, the Spaniards carried out hydrographical surveys of the coast, and attempted to establish settlements. These would be of importance should a northern passage to the Atlantic eventually be discovered. The final expedition is described, with translations of the reports, by Mr. H. R. Wagner in papers reprinted from the *Quarterly* of the California Historical Society for 1931. It has been somewhat overlooked by historians, and perhaps is worthy of note as the last of its kind. The instructions issued to the leaders reflect the motives referred to above, but in addition the exploration of the Columbia river was specially enjoined. The proposals met with opposition from several Spanish officials, partly on the ground that Vancouver's surveys could not be improved upon, for though Vancouver had not published his results at that time, he had exchanged charts with the Spaniards. Two vessels, the *Mexicana*, under Martinez y Zayas, and the *Activa* under Eliza, left San Blas in April 1793. The former reached the Strait of San Juan de Fuca, and Zayas made a "Carta esferica" of the coast southwards to San Francisco, and several plans of likely harbours, including the mouth of the Columbia (Entrada de Ezeta) and Tomales Bay. He sailed some distance up the Columbia, but after going aground, all attempts at further exploration were abandoned. Indeed there seems to have been little determination behind these efforts, for the *Activa* returned with nothing accomplished.

The second part of the paper deals with an attempt, in the same year, to establish a settlement on Bodega Bay, some 50 miles north of San Francisco. This had been discovered by one of Vizcaino's ships in 1603, and rediscovered and named in 1775 by Bodega y Quadra. J. B. Matute was dispatched in the *Sutil*, but after a half-hearted attempt at building a fort, abandoned on the excuse of lack of timber and water, he returned to San Blas. No further attempts at settlement were made, largely because of the improvement in diplomatic relations between Spain and England.

GEODETIC SURVEY OF CANADA

The Annual Report of the Geodetic Survey of Canada for year ending 31 March 1930 shows continued and satisfactory progress in the Geodetic Survey.

The use of aeroplanes, both for reconnaissance and for transport, has been found very successful. In one area, in Western Quebec, where conditions for the use of hydroplanes were particularly favourable, no other means of transport were used. A ground check on aeroplane reconnaissance (for the selection of triangulation stations) carried out in Quebec showed that the method was quite reliable; of twenty-six stations selected from the air, only one could not be used. This reconnaissance took only ten days, whereas by ground methods two seasons would have been required, owing to the difficulties of movement. In connection with work in this Province it is mentioned that the new $5\frac{1}{2}$ and $3\frac{3}{4}$-inch theodolites have proved ideal for the work, but unfortunately the make and type of the instruments are not given.

A curious case of errors in angular measurement, in the triangulation in Saskatchewan, is quoted. Every effort was made to locate the source of error, without success, except apparently to eliminate all causes other than continuously unfavourable atmospheric conditions. Owing to this trouble 93 per cent. of the stations had to be occupied more than once, some as many as five, six, and, in one case, ten times; with consequent serious delay to the work in that region.

Levelling makes good progress, and the fixing of fundamental bench marks is proceeding steadily. The practice has been adopted of attaching plates to all bench marks showing their elevation. In addition to this, full information about all bench marks is published in pamphlets, of which nine, including 8128 bench marks, had been issued up to the end of the year under review. The Report, as usual, contains a number of illustrations and some excellent diagrams. E. M. J.

THE "GENTE HERMOSA" ISLAND OF QUIROS

A correspondent, Mr. H. F. Aitken, sends us a short article on the identification of the island in the Central Pacific discovered by the Spanish navigator Quiros in his voyage of 1606, and by him named Gente Hermosa ("Beautiful People"). This has been generally identified with a small uninhabited island in about 11° S., 171° W., visited by Captain Hudson, of Wilkes's expedition, and by him named Swain's Island, after the master of a whaler who informed him of its existence. Mr. Aitken holds that this idea is mistaken, and enters into an elaborate discussion of the question, which is too long to print in full, but of which the main points may be summarized. Quiros, he says, after passing through the Tuamotu group, reached a latitude of 10° S. near 155° W., then shaping a course to the west, and lighting on an island which he called San Bernardo, thinking it was the same which he had seen when with Mendaña in 1595. A little later (1 March 1606) he discovered another island which was named Gente Hermosa. At daylight the voyagers found themselves at the north end of an island about 6 leagues

in circumference, which lay north and south and had a lake in the middle, terms used also to describe the island being "overflowed," or "inundated." The natives were tall, well-made, and handsome, which accounts for the naming of the island. On being asked for water they brought a little and said it could be obtained at a point across the lagoon, where in fact a small amount was found in a little pool near a village. Mr. Aitken points out with reason that Swain's Island agrees in no particular with this description, being nearly round and elevated 15 to 25 feet above the sea. The sea breaks constantly on all parts and no safe landing exists, while Captain Hudson found no trace of its ever having been inhabited. On the other hand, the most southerly island of the Tokelau group, Fakaofo, with its lagoon 19 miles in circumference (supposed to have been first seen either by Captain Morvan of the *Adolphe* of Morlaix, or by Wilkes, who named it Bowditch), does fit in well with the description of Gente Hermosa, and is in fact the only island near 10° S. from the Marquesas to the Gilbert Islands which does so. Fakaofo islet, where Wilkes found a village with a well near it containing 2 feet of water, does lie "across the lagoon" from the north end where the ships landed. Quiros's previous landfall (his San Bernardo) has been identified with Manihiki, and the distance from this to Bowditch accords with the 200-leagues' interval given by the Spanish navigator. His latitude for San Bernardo (if this was Manihiki) was too far south by 24′, and he also puts Taumako in the Santa Cruz group, the next land sighted after Gente Hermosa, 23′ too far south. He was therefore farther north than he thought he was (as was recognized by Dalrymple), and if we apply a similar correction to his latitude of Gente Hermosa (10° 20′ S.) we are not far from the true position of Bowditch Island.

Mr. Aitken also discusses briefly the course taken by Mendaña in his voyage of 1595, and concludes that his San Bernardo was Danger Island, some distance south-east of Fakaofo, and that the low round island, found 400 miles farther west and named Solitaria, was Swain's Island.

THE FOUR-METRE SOUNDING TUBE OF THE *SNELLIUS* EXPEDITION

In the *Annalen der Hydrographie* for March (1932) Dr. Ph. Kuenen gives an account of a large tube for obtaining stratified samples of the sea-bottom which was used on board the *Snellius* with great success in deep water during the expedition of 1929–30 to the Dutch East Indies. The longest tube-sample hitherto recorded was secured by the *Meteor* expedition, and had a length of 98 cm. The *Snellius* expedition was able to recover samples whose average length out of fourteen soundings was 150 cm. and of which the longest reached 206 cm. The deepest sounding was in 5000 m., and at this depth a tension of 650 kg. was required to recover the tube.

The tube was constructed on the same principles as the *Meteor's* bottom-sampler. The inner diameter of the tube was 45 mm. and the external 60 mm. An important feature was however the cutting-edge, consisting of a block screwed to the bottom of the tube, whose diameter was 75 mm. Unless this edge have a larger diameter than the external diameter of the tube, the tube sticks irrecoverably fast in the bottom sediments. It was found that a special valve at the base of the tube was hardly necessary. The sediments were indeed so firmly seated in the tube that their transference to the glass storage tubes was tiresome and difficult. Dr. Kuenen holds that with a tube a centimetre wider, longer by a metre or two and somewhat heavier (weight of present tube and weights is 160 kg.), longer samples would be obtained without any difficulty, even where the bottom was of fairly hard material.

RELATIVE TERMS FOR GEOGRAPHICAL POSITION

Even at the present day we frequently use terms for geographical position which have a definite meaning only in relation to the speaker or writer. Examples taken at random are the Far or Near East, the North Sea, or Transjordania. Yet more was this the case in ancient times when primitive use was still dominant and there was little attempt at scientific precision. An interesting study of the usage of the Greeks and Romans in this field has been made by Dr. H. Stürenburg, who has published the results in a pamphlet entitled 'Relative Ortsbezeichnung: zum geographischen Sprachgebrauch der Griechen und Römer' (*Leipzig and Berlin: Teubner* 1932). More than thirty years ago the same writer considered a single aspect of the subject in a paper on the designation of river banks among the Greeks and Romans, and he has now returned to the subject and dealt with it comprehensively. He points out that though when Herodotus spoke, *e.g.*, of Asia *within* the Halys, there is no doubt of the meaning it would convey to a Greek, in many other cases one cannot be quite sure, and the reconstruction of early battles may be hampered by the uncertainty as to the significance of terms like the near or far side of a river. Dr. Stürenburg has culled his examples from a wide field of classical literature and arranges them under headings like "here" and "there," "before" and "behind," "inner" and "outer," "upper" and "lower," "right" and "left," with a preliminary section on the early designations of the Mediterranean ("this," "our," etc.). Cases of doubtful meaning are fully considered, and the writer sometimes explains them differently from other commentators. The idea of front and back is not always consistently applied. If used in reference to men or things in motion there can be no doubt of the meaning, but when the terms are used of parts of the Earth's surface there is more uncertainty. Thus in Strabo Mauretania has a front towards the Atlantic, while in Herodotus the Phoenicians returning from the circumnavigation of Africa enter the Mediterranean from behind. The terms "inner" and "outer" are in general used with reference to the Mediterranean as centre, but there are examples of a different use. Thus Strabo speaks of the side of Italy towards the Adriatic as outer, while Arrian in describing India takes his stand on the east side of the Indus and speaks of the parts west of the river as outside. Interesting cases might be multiplied, but enough has been said to show the value of the study. Dr. Stürenburg promises a similar discussion of terms of position in German-speaking countries, where a great variety are still in popular use.

THE JUNGFRAUJOCH SCIENTIFIC STATION

We have received a publication describing the buildings, surroundings, and plan of work of the station recently opened, under international jurisdiction, at 10,000 feet on the col between the Jungfrau and Mönch close to the Eiger and Aletsch glaciers. The situation at the terminus of the Jungfrau railway assures accessibility at all seasons, and rapid movement to and fro of personnel, instruments, and books. Among the more important contributions may be mentioned an account of the history and object of the enterprise by Dr. W. R. Hess, of Zürich, of the geology and geography of the locality by Professor L. W. Collet, of Geneva, and a somewhat lengthy paper by Drs. J. Maurer and O. Lütschg, of Zürich, on meteorology and hydrology. There are two short English contributions respectively by Dr. G. M. B. Dobson, of Oxford, on the possibilities offered by the new observatory for the study of atmospheric ozone, and Sir F. G. Hopkins, of Cambridge, on possibilities of research on biochemical lines. The volume is handsomely illustrated by photographs of the building and its environment, including a portrait of the late Dr. A. De Quervain, the originator of the project.

HARMONIC TIDAL CONSTANTS FOR DURBAN

At the end of his paper on Tidal Observation on the Great Barrier Reef Mr Michael Spender related lightheartedly how he had undertaken to convert the captain of the ship in which he sailed to the use of Harmonic Tidal Constants. They calculated together the tidal curve for the day of their arrival at Durban from Admiralty Tide Tables Part II (1927) and were very pleased with the result until the navigating officer pointed out that their results showed a foot more water than the prediction for the day in the Admiralty Tide Tables Part I. Mr. Spender attributed the discrepancy to a misprint in Part II, corrected later in Supplement No. 1, 1929; but "Harmonic Constants were lost as a subject of conversation for the remainder of the voyage." The story was, we think, directed by the writer against himself as an apostle, rather than against the Admiralty Tide Tables; but we are glad to publish the following letter from the Hydrographer, to make it clear that there was no misprint, and that the italic figures for A_0 in the tables of Part II, 1927, should have warned Mr. Spender that the accurate relation between the datum of Admiralty Charts and the Harmonic Tidal Constants was still in doubt when Part II was published. The Hydrographer writes on 23 April 1932:

"Referring to the last paragraph of Mr. Spender's article on tidal observations on the Barrier Reef, in the March number of the *Journal*, and particularly to the last few lines of this paragraph, I have to inform you that the value of A_0 at Durban, 3·9 feet, given in the Admiralty Tide Tables 1927, Part II, was not a misprint, but was the then accepted value, obtained by subtracting the half spring range of the tide, derived from the harmonic constants, from the accepted height of mean high-water springs. The value so obtained was printed in italic type, *showing it to be an assumed value*. The assumed value was corrected at the first opportunity after the computation of more exact data.

"Tidal data for the world are still incomplete, even at important ports; it is therefore necessary, in these cases, to publish approximate or assumed information, and all that can be done is to indicate to the user of the tables when the published information is of this nature.

"I therefore hope that you will be able to arrange for the appearance in the next issue of the *Journal* of an explanation of the misunderstanding."

CORRESPONDENCE

GLACIATION AND CONTINENTAL DRIFT

In response to the invitation of the *Journal* I am glad to state my entire agreement with Professor Coleman in his conclusion that the facts of Pleistocene and Permian glaciations are completely opposed to the theory of continental drift and also, I may add, to the suggestion of wandering poles. Professor Coleman's argument is incontrovertible. The correlation of glacial epochs in different parts of the world rests upon sound evidence and cannot be in error to the degree which would be necessary to shift the continents or the poles in such manner as to bring the various regions under either pole at successive times. Certain glaciations were simultaneous in widely separated latitudes and longitudes, and were so distributed that no possible rearrangement of lands could have brought them all within an arctic circle at the same time.

It may be regarded as pertinent to cite certain occurrences which have come

under my observation. Being familiar with the evidence of successive glaciations in western as well as in eastern North America, I have had opportunity to compare them with those of Patagonia and New Zealand. There are close parallels for which precise localities can be given.

New Jersey	latitude 41° N.	longitude 74° W.
Lake Chelan	„ 48° N.	„ 120° W.
Lake Nahuel Huapi ..	„ 41° S	„ 71° 30′ W.
Lake Wanaka	„ 44° 40′ S.	„ 169° E.

The occurrences of glacial deposits of successive ice epochs in New Jersey are well known and are correlated with the European stages. In each of the other districts in the northern and southern hemispheres the moraines of the latest glaciation are exceedingly fresh and glaciers linger on the adjacent mountains. The identity of the epoch is beyond question. Glaciation was contemporaneous in all four widely separated regions.

Around Lake Chelan and Lake Nahuel Huapi there are in each case evidences of two earlier glaciations, making three in all in each district, with similar indications of relative severity and antiquity. At Lake Wanaka Dr. Benson, of Dunedin, guided me over the latest moraines, as fresh as any of the last ice-sheet of North America or Europe, and, climbing 1100 feet, we chanced upon a very ancient moraine in which boulders of mica-gneiss were completely decomposed. The valley of Cardrona river has been eroded during the long lapse of time intervening between the two glaciations, covering probably most of the Pleistocene. No search could be made at the time for intermediate glacial records, but there can be no doubt they exist.

It is more amusing than instructive to attempt to shift either the continents or the poles back and forth to account for successive glacial and interglacial epochs in these several districts, under the condition of contemporaneous repetitions. Even if we give Pleistocene time a million years or so the rapidity of the movements and their magnitude would put an inconceivable strain upon Mother Earth and organic evolution would have had to adjust itself to incessant flight.

This is but one illustration of the many in which the test of Wegener's theoretical suggestions results in a *reductio ad absurdum*. They are, in my opinion, so flatly in contradiction with the facts of geophysics and geological history that I have never taken them seriously. The vogue that the ideas enjoy is, to my thinking, a psychological rather than a geological problem. A number of questions are made more difficult than they really are by attempting to make the facts fit some hypothetical, unnatural concept, such as that of the mathematicians' homogeneous globe or the survival of an original crust after a billion years of eruptive activity.

Lyell was a sane leader. His methods of reasoning are still good. Even that crucial problem of all glacial problems—the glaciation of South America, Africa, India, and Australia during Permo-Carboniferous ages—in regard to which Professor Coleman seems at a loss, will, I think, yield a solution in complete harmony with the principles of climatology under the assumption of permanent continents and ocean basins, provided we recognize variations of level, marginal changes, and isthmian connections.

BAILEY WILLIS

Stanford University, California, U.S.A. 5 *May* 1932.

MEETINGS: SESSION 1931–1932

Sixth Afternoon Meeting, 18 April 1932. The President in the Chair

Paper: The Weather on a Greenland Air Route: Discussion of Meteorological results of the B.A.A.R.E. By Mr. S. T. A. Mirrlees

Twelfth Evening Meeting, 25 April 1932. The President in the Chair

Elections: Ernest Baker; Miss Dorothea M. A. Bate; John Harold Beausire; Charles Albert Ernest Carr; Bosworth Edwin Monk Goldman; William John Hacker; Peter Edward Clement Harris; Rev. Herbert John Ivens, D.D.; Bassett Jones; Captain Archibald John Joynson, R.E.; Mrs. Henry Laming; Mrs. Rosemary MacCarthy-O'Leary; Mrs. Kenneth Mason; Eric Hatton Miller; Sidney James Noel-Brown; Edward Henry O'Malley; N. R. Rice; James Wylie Smith; Rev. Eric Somerville Somerville; Robert Edward Frederick Tendall

Paper: Headwaters of the Irrawaddy. By Mr. F. Kingdon Ward

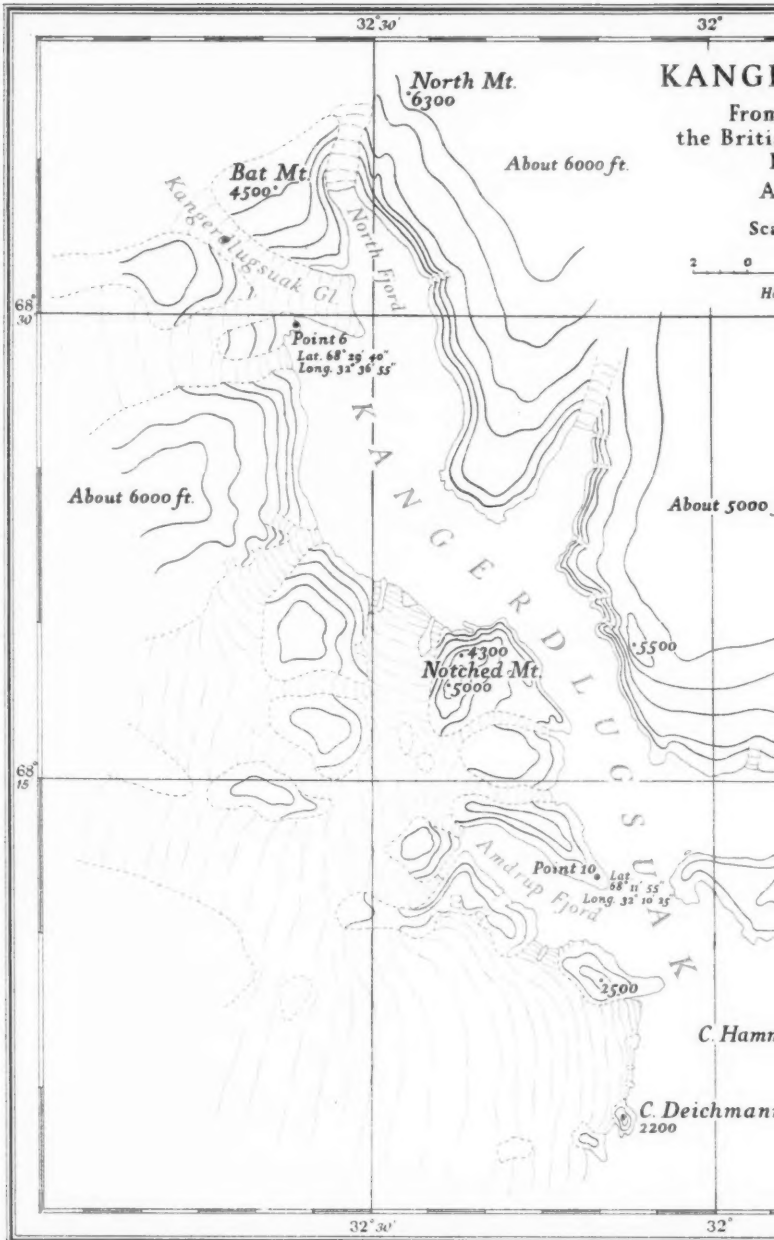
Seventh Afternoon Meeting, 2 May 1932. The President in the Chair

Paper: Colour Photography for Travellers. Discussion opened by Captain George Sherriff and Dr. D. A. Spencer. Projection of colour plates and films by several workers, and demonstration of Kodacolor Kinematograph process by Mr. F. B. Phillips

Thirteenth Evening Meeting, 9 May 1932. The President in the Chair

Elections: John Angus Beckett; Miss Florence M. Bonnyman; Percy Edward Brown; Captain P. E. Cayley; William Manning Cochran, B.A., B.SC.; Flt.-Lt. Narbrough Hughes D'Aeth, R.A.F.; Miss Blanche Mary Davidson; Miss Eleanor Mary Francis; Aubrey V. Guy; Andrew Ashton Henderson; Flt.-Lt. Frederick Wilmot Midlemist Downer, R.A.F.O.; Arthur Andrew Holland; Lim Soo Kok, A.M.I.C.E., F.S.I., M.R.S.I.; Donald Copeland Gibson MacKay, M.A.; Lt.-Col. Gilbert Mackereth, M.C.; Captain Frank Mellor; Arthur E. Moodie, B.A.; Henry W. Shoemaker; Miss Eva Constance Thomson; Jonkheer A. P. A. Elias van Stabrouck; Frank Percival Wilson

Paper: The Prehistoric Geography of the Kharga Oasis. By Miss Gertrude Caton-Thompson



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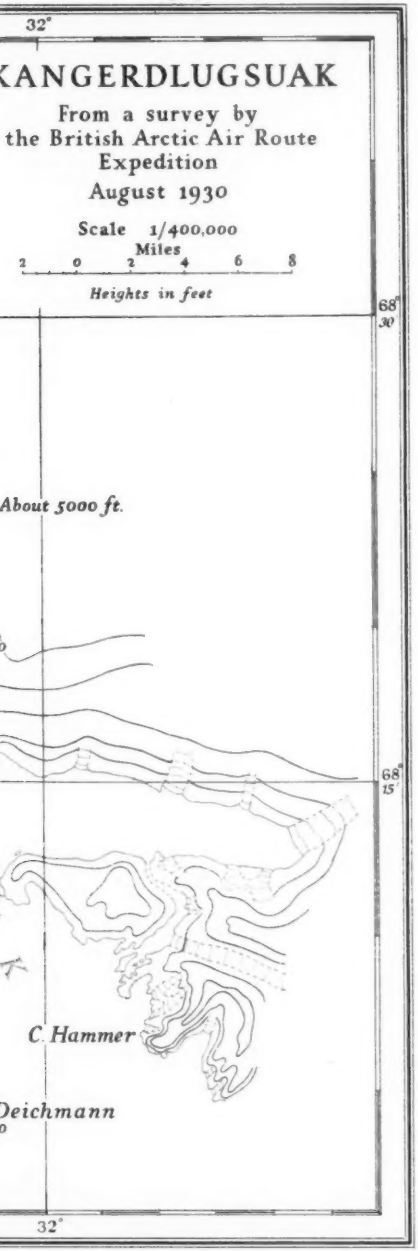

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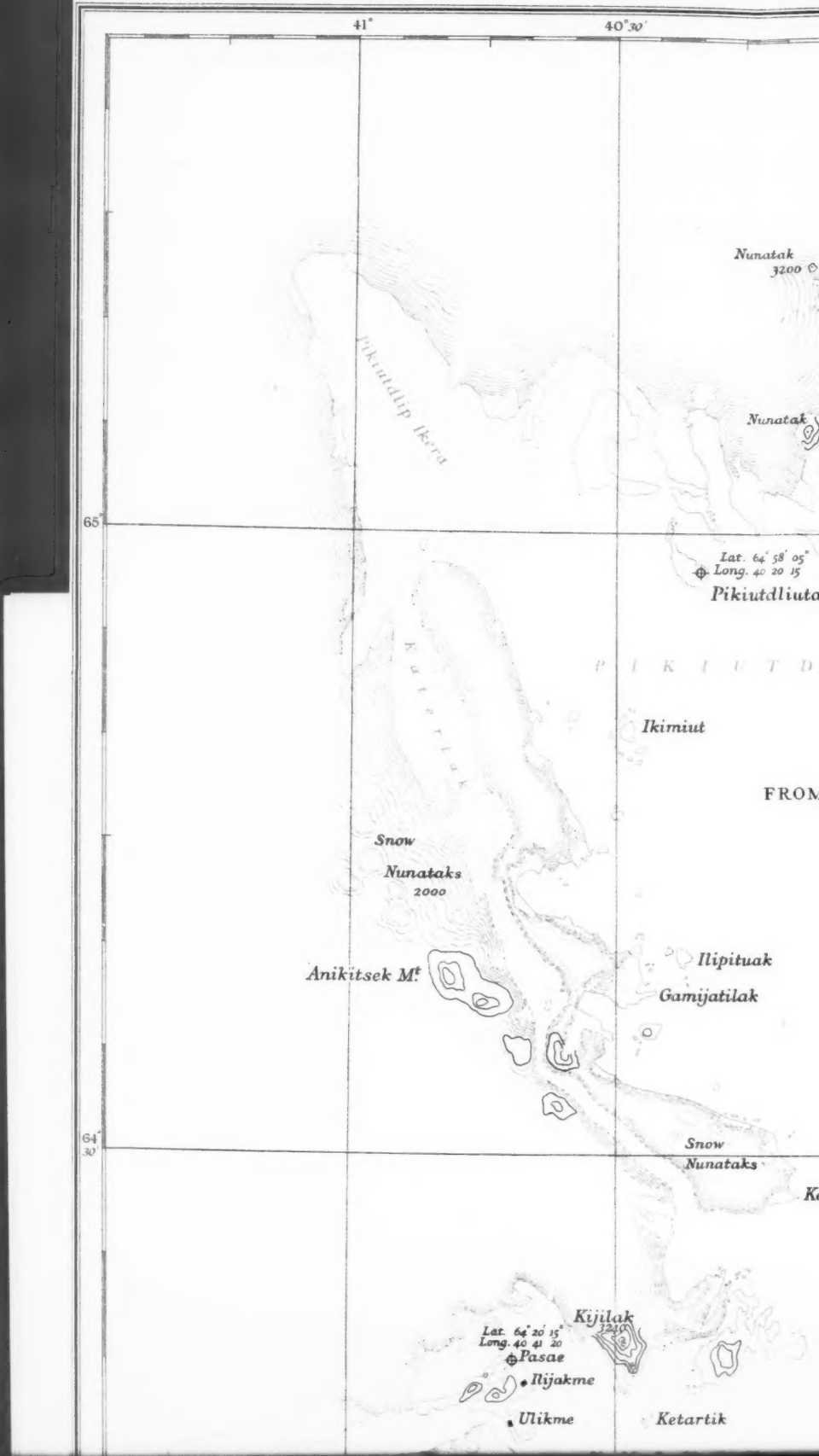
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40°30'
Nunatak
3200
Nunatak
Pikiutdliup Ikerra
65°
Lat. 64° 58' 05"
Long. 40 20 15
Pikiutdliuta
P I K I U T D
Ikimiut
FROM
Snow
Nunataks
2000
Anikitsek Mt
Ilipituak
Gamijatilak
64°
30'
Snow
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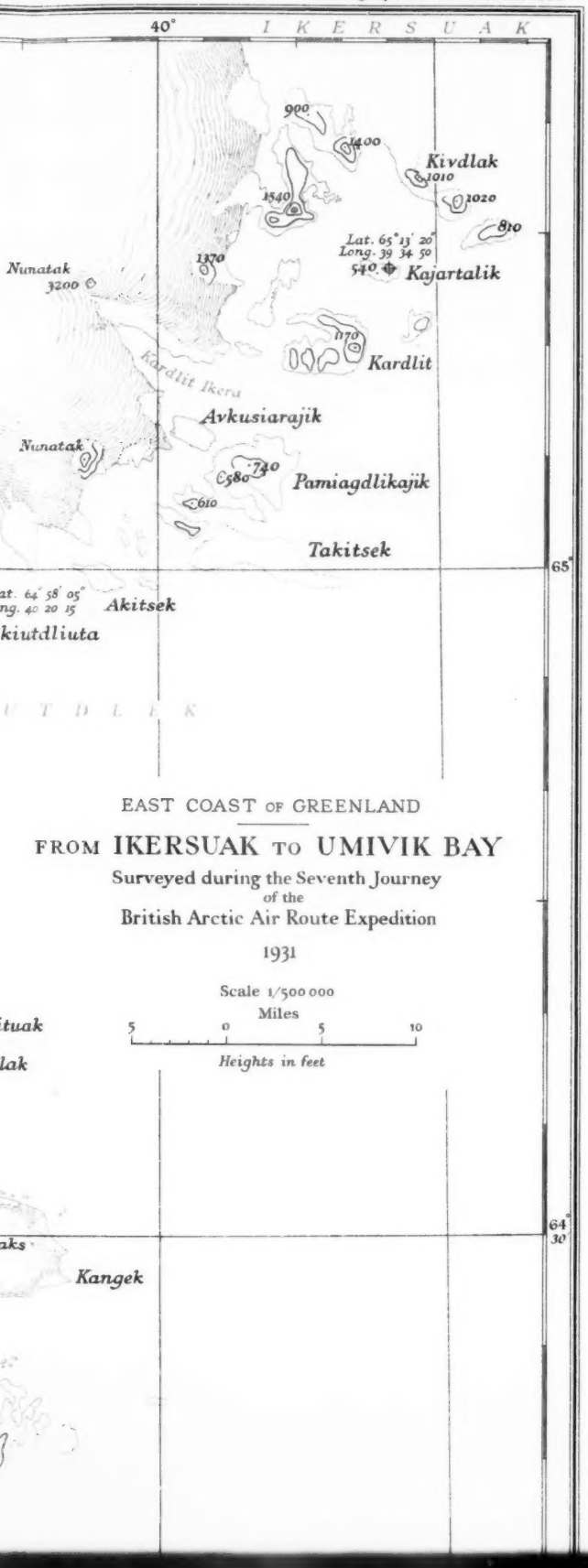
3240
Lat. 64° 20' 15"
Long. 40 41 20
Pasae
Ilijakme
Ulikme
Ketartik



EAST COAST OF GREENLAND

FROM IKERSUAK TO UMIVIK BAY

Surveyed during the Seventh Journey
of the
British Arctic Air Route Expedition

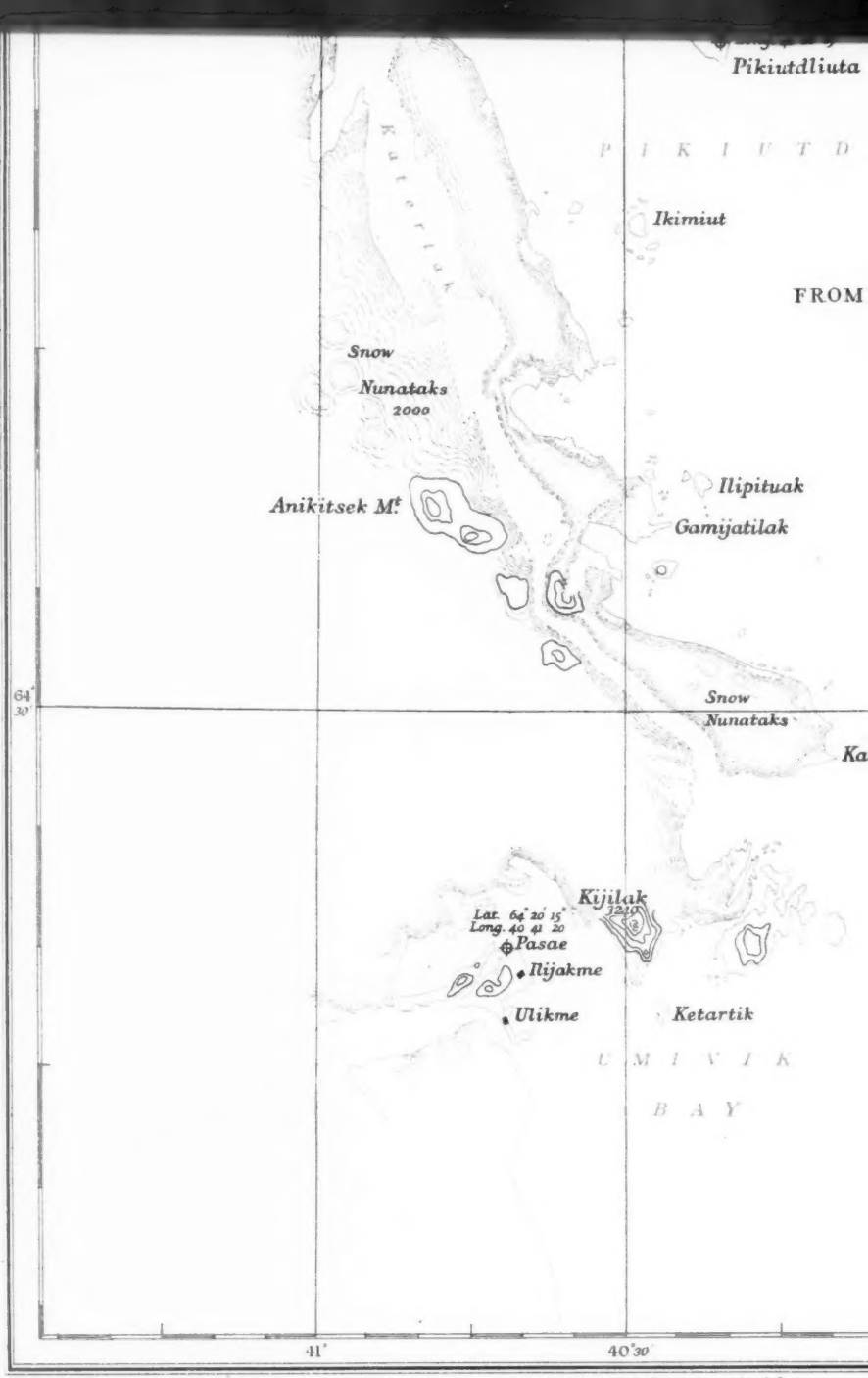
1931

Scale 1/500 000

Miles

5 0 5 10

Heights in feet



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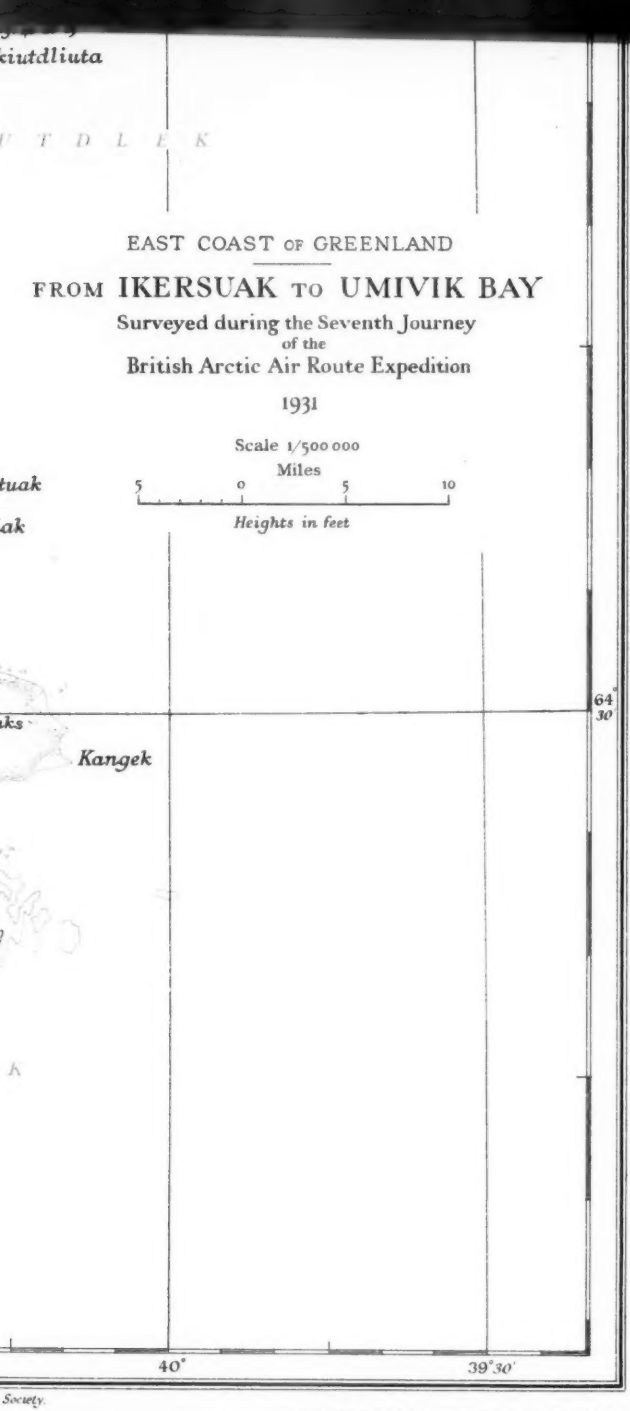

IKERSUAK TO UMIVIK BAY
British Arctic Air Route Expedition